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Remediation of Soiled Masonry in Historic Structures Contaminated by the Gulf Coast Oil Spill of 2010

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Remediation of Soiled Masonry in Historic Structures Contaminated by the Gulf Coast Oil Spill of 2010

by

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Abstract

Remediation of Soiled Masonry in Historic Structures Contaminated by the Gulf Coast Oil Spill of 2010

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The University of Texas at Austin, 2011

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- The objective of this thesis was to understand the factors that affect the selection of remedial treatments for the complex staining of masonry materials on cultural resources located in environmentally sensitive sites such as Fort Livingston, Louisiana, on the Gulf Coast of the United States and other locations impacted by pollutants including crude oil. After the Deepwater Horizon oil spill in April 2010, the brick-and-tabby Fort was stained by crude oil. The EPA recommends SWA for removal of oil from solid surfaces such as masonry; however, limited research has been conducted into SWA effective for removal of crude oil from masonry, particularly in remote and environmentally sensitive locations. Research was conducted collaboratively at NCPTT and UT-Austin to identify a series of suitable SWA and to develop methods for evaluating SWA effectiveness in the laboratory. Products were selected for laboratory evaluation that do not require long dwell times, are easy to transport to the site, can be

applied with portable equipment, produce effluent that can be collected for off-site disposal, and are listed on the EPA-published NCP Product Schedule.

Two sets of 36 brick samples each were soiled with crude oil from the Fort. One set of samples was artificially weathered and one set was unweathered prior to being cleaned with selected six SWA. Laboratory evaluation shows that the primary factor affecting cleaner selection for remediation of brick masonry stained by light crude oil is the extent of weathering of oil on the masonry. For light crude oil, such as that spilled in the Gulf, organic solvent-based cleaners may be most effective if cleaning is possible soon after the staining occurs. Aqueous surfactant cleaners are most effective for removing weathered light crude oil from masonry. The following SWA listed in order of performance are recommended for field trials at Fort Livingston:

1. Cytosol
2. SC-1000
3. De-Solv-It APC
4. De-Solv-It Industrial followed by De-Solv-It APC
5. De-Solv-It Industrial followed by SC-1000

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Chapter 1: Introduction

1.1 Introduction

The objective of this report is to address the following question pertaining to contaminated masonry materials:

What are the factors that affect the selection of remedial treatments for the complex staining of masonry materials on cultural resources located in environmentally sensitive sites such as Fort Livingston, Louisiana on the Gulf Coast of the United States and other locations, which are impacted by pollutants including crude oil?

Since the United States (US) Congress enacted the National Historic Preservation Act (NHPA) in 1966, the US Department of the Interior and other cultural resource preservation agencies[1] have fostered a conscious and systematic effort to help preserve America's cultural resources through processes such as the Section 106 Review and publications such as the Secretary of the Interior's Standards for the Treatment of Historic Properties. Amendments to the NHPA in 1992 helped establish the National Center for Preservation Technology and Training (NCPTT, Center). NCPTT is a research division of the National Park Service (NPS), and is the only preservation research and technology center of the NPS. The Mission statement of the Center states that, "NCPTT advances the application of science and technology to historic preservation. Working in the fields of archeology, architecture, landscape architecture and materials conservation, the Center accomplishes its mission through training, education, research, technology transfer and partnerships."[2]

A growing recognition for preserving cultural heritage resources has enabled research and innovation in conservation techniques to enable the use of modern technology for preserving the past. In many cases these innovations have been necessitated by exigent circumstances and unprecedented problems including natural calamities and man-made disasters.

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[1] Preservation agencies such as the Advisory Council on Historic Preservation (ACHP) and the State Historic Preservation Offices (SHPO) were established as a result of the NHPA.

[2] "NCPTT | About." *NCPTT | National Center for Preservation Technology & Training | National Park Service*. N.p., n.d. Web. (Accessed on October 12, 2010) <http://www.ncptt.nps.gov/about-us/>.

Most recently, the aftermath of the Deepwater Horizon/British Petroleum (BP) oil spill in the Gulf of Mexico (Gulf) has posed an unprecedented challenge in terms of scale and impact. On April 20, 2010 the Deepwater Horizon oil drilling rig exploded in the Gulf, approximately 50 miles southeast of the Mississippi Delta. The accident resulted in the death of eleven workers followed by the burning and sinking of the drilling rig. Additionally, as a result of the explosion, an uncapped underwater oil well released nearly five million barrels worth of crude oil (crude, oil) in the Gulf until the well was capped on September 19, 2010 after numerous unsuccessful attempts.

According to updates issued by the Federal Government of the United States (Federal Government) on August 2, 2010,[3] the BP oil spill is the largest marine oil spill in history. In addition to the immense ecological and economic impact, the BP oil spill continues to have heretofore unknown effects in the Gulf Coast states of Alabama, Florida, Louisiana, Mississippi, and Texas. Cultural resources including a series of historic coastal military forts[4] and ecologically sensitive sites[5] in the Gulf are particularly threatened by the oil spill.

In late May and early June 2010, brick masonry at Fort Livingston, Louisiana (Fort) was contaminated by oil from the BP oil spill[6]. In accordance with the Oil Pollution Act of 1990 (OPA),[7] oil spill clean-up efforts were coordinated by BP and the state of Louisiana; however, the Louisiana Office of State Parks and State Historic Preservation Office (SHPO) requested NCPTT's guidance on the removal of oil contamination from the historic Fort.

Response strategies for remediation of historic properties affected by the BP oil spill have been impacted by the lack of information related to remediation of crude oil from historic masonry. Additionally, treatments on cultural resources located in marine environments require approaches suitable for unusual site conditions such as partial or complete submersion in water,

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[3] "Press Release." *Restore the Gulf*. The United States Government, n.d. Web. (Accessed on August 4, 2010) <http://app.restorethegulf.gov/go/doc/2931/840475/>.

[4] Fort Morgan in Alabama, Fort Jefferson and Fort Pickens in Florida, Fort Livingston in Louisiana, and Fort Massachusetts in Mississippi are located in the Gulf Coast.

[5] Gulf Islands National Seashore, Grand Isle State Park, and Dry Tortugas National Park are located on the Gulf Coast.

[6] Chin Carol. " Ft. Livingston Grand Terre Island Field Report." *NCPTT | National Center for Preservation Technology & Training | National Park Service*. N.p., n.d. Web. (Accessed on October 12, 2010) <http://www.ncptt.nps.gov/>.

[7] "Oil Pollution Act Overview | Emergency Management | US EPA." *US Environmental Protection Agency*. N.p., n.d. Web. (Accessed on November 29, 2010) <http://www.epa.gov/oem/content/lawsregs/opaover.htm>.

tidal cycles, and exposure to severe weather conditions including strong winds, thunderstorms, and hurricanes. Masonry located in ecologically sensitive or remote marine locations also imposes constraints on commercial cleaning products that can be used without adverse effects on the marine environment and water column. Due to the lack of available information and in response to the request for guidance from the State of Louisiana, NCPTT is conducting research to evaluate methods for the remediation of crude oil from historic masonry.

Fort Livingston is used as a case study to understand factors that affect the selection of remedial treatments of masonry materials in cultural resources located in environmentally sensitive sites, and which are impacted by pollutants such as crude oil. The focus of the research presented in this report is to develop a methodology for use in the evaluation of cleaning methods and materials for brick masonry contaminated by crude oil. The research presented in this report was conducted within the framework of the on-going research conducted by NCPTT. Research activities for this study were conducted at the University of Texas at Austin (UT), Texas Department of Transportation (TxDOT) laboratories, NCPTT laboratories, and on-site at the Fort when possible.

1.2 Effect of the BP Oil Spill in Louisiana

Grand Isle, in Jefferson Parish, the only occupied barrier island in the state, is a major tourist destination, especially for outdoor recreation.[8] The island is located at the mouth of the Barataria Bay in the Gulf, and is reputed to be one of the top ten fishing spots in the world. It is equally popular for bird-watching, crabbing, camping, surfing, and its beaches. After the BP oil spill the beaches of Grand Isle, which are a part of Grand Isle State Park, and recreational and fishing locations in the Gulf were closed due to oil contamination. In April 2011, the beaches of Grand Isle continue to remain closed to the public due to oil contamination on the shoreline. According to the Louisiana Department of Wildlife and Fisheries, several locations off Grand Isle

[8] According to the Louisiana Department of Culture, Recreation and Tourism (CRT), tourism attracts 23.3 million visitors to the state annually and generates $864 million in associated tax revenue. Without this revenue every household in the state would pay $543 in additional state tax. The tourism industry also enables employment for 184,000 people. Louisiana also has a significant nature-based tourism program that contributes over $4.7 billion annually to the state economy and generates $225 million in state tax revenue.

also remain closed for recreational and commercial fishing due to oil contamination in the water column.[9]

1.2.1 Fort Livingston, Louisiana

Fort Livingston, the only coastal fort in the Gulf of Mexico in Louisiana, is located on the western tip of Grand Terre Island, approximately five miles northeast of Grand Isle (Figure and Figure). Although it was never used for military purposes, the Fort was occupied by Confederate troops in 1861 for one year. The Fort was abandoned after the Civil War and was returned to the state of Louisiana in 1923. It is listed on the National Register of Historic Places since 1974 (NRHP Reference #740009254) and is managed by the Louisiana Office of State Parks.

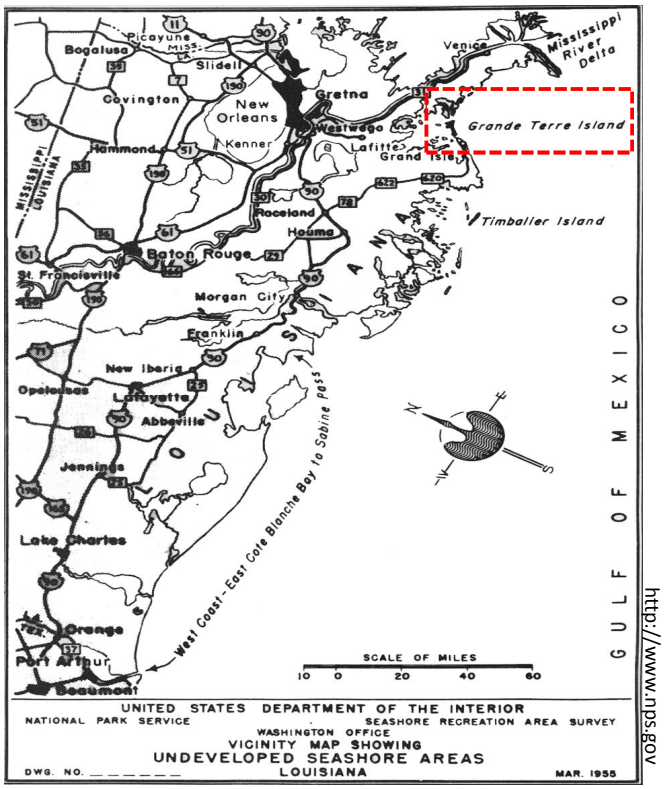

Figure 1.1: Grand Terre Island, Louisiana

[9] "Oil Spill Response | Louisiana Department of Wildlife and Fisheries." *Louisiana Department of Wildlife and Fisheries*. N.p., n.d. Web. (Accessed on December 13, 2011) <http://www.wlf.louisiana.gov/oilspill>.

Fort Livingston is one of the Third System coastal defense forts which were built between 1816 and 1870 to guard the main harbors, rivers, and naval yards of the United States; the forts represent a significant part of US coastal defense history.[10] The Fort is one of the largest coastal forts in Louisiana and is a classic example of coastal American architecture from the early- to mid-19th century. Construction of the brick, tabby, and granite structure began in 1841 or 1842 under the direction of Colonel Joseph Gilbert Totten. All the ancillary structures built during construction such as the overseer and laborers' quarters, kitchens, trade shops, stables, hay house, and lime shed were destroyed by hurricanes over the decades. The southeast side of the Fort was destroyed in a hurricane in 1915; however, the remaining structure is in good condition.[11]

Figure 1.2: Aerial view of Fort Livingston, Grand Terre Island, Louisiana[12]

[10] "Gulf Islands National Seashore - Draft Fire Management Plan 2009 (U.S. National Park Service)." *U.S. National Park Service - Experience Your America*. N.p., n.d. Web. (Accessed on April 17, 2011) <http://www.nps.gov/guis/parknews/draft-fire-management-plan-2009.htm>.

[11] "Fort Livingston NR Nomination." *CRT - Home Page*. N.p., n.d. Web. (Accessed on March 9, 2011) <http://www.crt.state.la.us/hp/nationalregister/nhl/search_results.asp?search_type=historicname&value=Fort+Livingston&pageno=1>.

[12] Bob Webster, Pryor, OK.

As described in the National Register nomination, the Fort is "... a trapeziform shaped stronghold, surrounded by a wet ditch and with outworks on the land side. The walls were constructed of cemented shell faced with brick and trimmed with granite. The bricks were shipped from either Pensacola or Mississippi; the shells were removed from local archaeological sites."

Shell concrete, or tabby, is a traditional construction material typical to the coastal areas of the southeastern US. Tabby is a mixture of lime from shells and shell fragments, sand, and water. Like traditional concrete, the mixture is formed using boards held together with wood ties and wedges.[13] The shells and shell fragments in the tabby mixture give it the distinctive look of a wall made of shells (Figure). In the 19th century, tabby was considered particularly suitable for military forts because cannonballs would be absorbed into tabby walls rather than cracking or shattering them.[14] Fort Livingston is the only fort in Louisiana to have interior walls and ramparts constructed of tabby. Although the tabby walls at the exterior of the Fort were originally clad in brick, the tabby on the interior walls was intentionally left exposed.

[13] Fischetti, David C. "Tabby: Engineering Characteristics of a Vernacular Construction Material." *Structural investigation of historic buildings: A case study guide to preservation technology for buildings, bridges, towers, and mills*. Hoboken, N.J.: John Wiley & Sons, 2009. 169-171. Print.
[14] "Fort Livingston NR Nomination."

Figure 1.3: Tabby on an interior wall of Fort Livingston

From the time of construction of the Fort, concerns were expressed regarding erosion of the shoreline in front of the structure. Jetties were constructed in 1853 to prevent shoreline erosion; however, by 1886 the shoreline was within 10 feet of the structure.[15] Over time, parts of the walls on the gulf-side of the Fort were submerged under seawater and remain submerged. After the 1970s, a continuous riprap breakwater was constructed around the gulf side of the structure to protect the Fort from direct wave action and to prevent further erosion of the shoreline (Figure).

[15] Ibid.

Figure 1.4: Oil boom around Fort Livingston with the riprap breakwater in the distance

A breach in the riprap breakwater (likely to have occurred after 2005, based on photos) allowed oil-contaminated water onto Grand Terre Island and caused oil contamination at the exterior and interior of the Fort after the BP oil spill. As shown in Figure 1. and Figure the exterior and interior walls of the gulf side of the Fort are covered in a thin, sticky coating of oil up to the high tide line, which appears to be up to six brick courses high during low tide. The tabby walls are contaminated up to eight inches from the base. Three granite steps on the stairs at the gulf side of the Fort are also contaminated with oil. As shown in Figure , the oil at the top surface of the steps is exposed to the sun throughout the day and is hardened.

Figure 1.5: Oil contamination above the water level at the exterior of the tabby, brick, and granite structure

Figure 1.6: Oil contamination on the interior brick, tabby, and sand at the Fort. Note: the biological growth on the tabby above the tide line may have existed prior to oil contamination.

Figure 1.7: Oil contamination on the granite stairs.
Note: the oil on the granite in the highlighted area is hardened.

1.3 Oil Spills and Masonry

The extent of damage to masonry from crude oil depends on the amount and length of exposure to oil. Porous masonry materials can absorb significant quantities of oil resulting in visual disfiguration the surface and accelerated deterioration of masonry due to staining, reduced water vapor transmission, or chemical attack as a result of cross-polymerization of oil. In marine environments, naturally occurring oil-digesting microorganisms help in the breakdown of oil on masonry; however, they may produce metabolic products such as oxalic and sulfuric acid that could, combined with crude oil deposits, deteriorate masonry and other building materials including stucco, mortar, metals, and wood.[16]

Crude oil contains volatile aromatic compounds such as benzene and toluene, which are categorized as hazardous air pollutants (HAP), and polyaromatic hydrocarbons (PAH), also highly toxic organic compounds. HAP and PAH weather at different rates and may penetrate building materials, resulting in a prolonged threat of toxic emissions in the surrounding air. In addition to inhalation of vapors, toxic exposure can also occur through direct contact with skin or

[16] Gu, Ji-Dong, Tim E. Ford, Neal S. Berke, and Ralph Mitchell. "Biodeterioration of concrete by the fungus Fusarium." *International Biodeterioration and Biodegradation* 41 (1998): 101-109.

eyes, ingestion, or absorption through wounds. The risk of HAP and PAH toxicity to humans is greatest immediately after a spill, which may prevent timely access to the site by response personnel.[17] Delayed response to oil contamination on solid surfaces may allow prolonged exposure of cultural resources to oil, or weathering of oil on surfaces, and may cause possible permanent damage.

Cleaning of historic masonry materials involves additional challenges such as avoiding permanent damage to building materials that may no longer be available. Response personnel determine suitable approaches for remediation of crude oil from historic properties based the location of the property, affected substrates, nature and extent of the soiling, extent of the area to be cleaned, accessibility to the soiled area, and economic feasibility.

1.4 Remediation of Cultural Resources Impacted by Oil Spills

Oil spills constitute the unintentional release of liquid petroleum into the environment, including marine or fresh water environments. According to the Environmental Protection Agency (EPA), almost 14,000 oil spills are reported each year that require local, state, and federal assistance.

In the US, the National Oil and Hazardous Substances Pollution Contingency Plan (National Contingency Plan, NCP) is the Federal Government's plan for responding to oil spills and hazardous substance releases. Under the NCP, an interagency National Response Team (NRT) and thirteen Regional Response Teams (RRT) led by the EPA and UCSG, provide emergency response during an oil spill.[18, 19, 20]

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[17] Wang, Zhendi, and Scott Stout. *Oil Spill Environmental Forensics: Fingerprinting and Source Identification*, Burlington: Elsevier, 2006.

[18] "Home Page." *US National Response Team Website*. N.p., n.d. Web. (Accessed on April 16, 2011) <www.nrt.org/Production/NRT/NRTWeb.nsf/HomePage?OpenForm>.

[19] The NRT is co-chaired by the EPA and USCG, and comprises the Federal Emergency Management Agency (FEMA), Department of Defense (DoD), Department of Energy (DOE), Department of Agriculture (USDA), Department of Commerce (DOC), Department of Health and Human Services (HHS), Department of Interior (DOI), Department of Justice (DOJ), Department of Labor (DOL), Department of Transportation (DOT), Nuclear Regulatory Commission (NRC), Department of State, General Services Administration (GSA), and Treasury Department.

[20] The EPA is the lead federal response agency for oil spills occurring in inland waters, and the US Coast Guard (USCG) is the lead response agency for spills in coastal waters and deep-water ports. "On-Scene Coordinators | Emergency Management | US EPA." *US Environmental Protection Agency*. N.p., n.d. Web. (Accessed on April 20, 2011) <http://www.epa.gov/oem/content/nrs/nrsosc.htm>.

In 1990 the Oil Pollution Act (OPA) was enacted in response to the Exxon Valdez (EV) oil spill in March 1989 in Alaska. The OPA established provisions that expanded the Federal Government's ability to respond to oil spills, and increased penalties for regulatory noncompliance by parties responsible for oil spills. The OPA amends the NCP and is the main Federal statute regulating oil spills; however neither the NCP nor OPA define comprehensive response guidelines for cultural resources affected by oil spills.[21] Cultural resources including historic properties are protected by Section 106 of the NHPA, which requires a review of any Federal undertaking that could impact historic properties, and requires a reasonable opportunity for the Advisory Council on Historic Preservation (ACHP) to comment on the undertaking.[22] During an oil spill, the Programmatic Agreement on Protection of Historic Properties during Emergency Response under the National Oil and Hazardous Substances Pollution Contingency Plan (Programmatic Agreement, PA) executed in 1997 provides an alternative process for review of Federal emergency response on historic properties.

According to the EPA, prior to the BP oil spill, the 1989 EV oil spill was the largest and most hazardous oil spill in US history. Like the BP oil spill, the EV spill was an unprecedented event and response teams used a wide range of techniques to mitigate damage from the spill. The scale of the spill, remote location, and adverse conditions, tested the ability of the NCP to address major oil spills. After the EV spill, although a significant threat to historic properties was identified, emergency response in Alaska focused on natural, tribal, and archeological resources because no historic properties are located in the immediate vicinity of the spill site. As a result, although the EV oil spill is the only spill in the US comparable to the BP oil spill, minimal research exists pertaining to the remediation of historic properties affected by oil spills, which can be used for remediation of historic properties impacted by the BP oil spill.

1.5 Research on Remediation of Oil-Contaminated Masonry at Fort Livingston

Phase 1 of this study focused on developing an experimental design and methodology to evaluate the effectiveness of cleaners on oil-contaminated brick. Phase 2 focused on the evaluation of selected cleaners through cleaning trials conducted on the oil-contaminated brick.

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[21] "National Response System Flowchart | Emergency Management | US EPA." *US Environmental Protection Agency*. N.p., n.d. Web. (Accessed on April 20, 2011) <http://www.epa.gov/oem/content/nrs/snapshot.htm>.

[22] "Section 106 Fact Sheet." *Advisory Council on Historic Preservation: Preserving America's Heritage*. N.p., n.d. Web. (Accessed on April 20, 2011) <http://www.achp.gov/docs>.

1.5.1 Phase 1 - Development of Experimental Design and Methodology

The objectives of Phase 1 were as follows:

1. Development of an experimental design
2. Development of sample preparation methodology
3. Sample preparation

The experimental design and methodology were developed specifically for the unusual constraints posed by the remote location of the Fort in a marine environment and the nature of brick soiling. Analytical methods suitable for evaluating the effectiveness of masonry cleaners on representative samples were identified during Phase 1.

Phase 1 also included a site visit to the Fort to document existing conditions and to collect samples of crude oil. The Fort is a protected cultural heritage resource and state regulations prohibit the removal of artifacts from the Fort. Therefore, brick samples from the Fort were not available for this study.

Representative samples were prepared in the laboratory through conditioning, soiling, and artificial weathering prior to cleaning trials. Detailed research methodology and findings are described in Chapter 3: Experimental Design and Methodology.

1.5.2 Phase 2 - Masonry Cleaning Trials and Evaluation

The objectives of Phase 2 were as follows:

1. Masonry cleaner selection
2. Development of cleaning methodology
3. Evaluation of selected cleaners through cleaning trials on oil-contaminated samples

Masonry cleaners were selected from a list of cleaners approved by the EPA and published in the NCP Product Schedule. After cleaner evaluations were completed, the efficacy of the selected cleaners was evaluated using colorimetry and visual evaluation of cleaned brick samples by thirty survey participants. The process of cleaner selection is presented in Chapter 4: Cleaner Selection; the results of cleaner evaluations are presented in Chapter 5: Cleaner Effectiveness. Conclusions and recommendations are provided in Chapter 6 and Chapter 7 respectively.

Chapter 2: Background

2.1 Crude Oil

Crude oil is a complex mixture of hydrocarbons ranging from simple volatile compounds like methane to large and complex nonvolatile molecules such as asphaltenes. The distribution of these compounds in crude oil imparts specific physical properties to the oil. All crude oils contain paraffins, naphthenes, and aromatics, however the specific composition of the crude oil depends on the geologic source of the oil; therefore, no two crude oils are identical.[1]

2.1.1 Crude Oil Weathering

As soon as crude oil is released into the environment and exposed to the atmosphere, water, and solid surfaces, its composition starts to change due to various chemical, physical, and biological processes. Additionally, oil and water emulsify due to wave action resulting in a mixture known as "mousse".[2] This change in composition of the crude oil continues to occur with continued exposure to the environment, in a process known as "weathering". Crude oil and its weathering products are distinguishable from other nearby sources of hydrocarbons based on the composition of the crude oil.[3]

2.1.2 Crude Oil Classification

The petroleum industry classifies crude oil based on geographical source or physical properties. Classification of crude oils based on properties depends on the density and sulphur content of the oil. High-density oil is classified as a heavy crude oil, and low-density oil is classified as light crude oil. Oil with a high sulphur content is considered "sour"; whereas oil with a low sulphur content is considered "sweet".[4] The Oil Spill Academic Task Force (OSATF)

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[1] Wang, Zhendi, and Scott Stout. *Oil Spill Environmental Forensics: Fingerprinting and Source Identification*, Burlington: Elsevier, 2006.

[2] "Making Mousse | Inspiring Students and Teachers | Serving Communities | NOAA's National Ocean Service Office of Response and Restoration." *NOAA's Ocean Service Office of Response and Restoration*. N.p., n.d. Web. (Accessed on January 21, 2011). <http://response.restoration.noaa.gov/topic_subtopic_entry.php?RECORD_KEY%28entry_subtopic_topic%29=entry_id,subtopic_id,topic_id&entry_id%28entry_subtopic_topic%29=272&subtopic_id%28entry_subtopic_topic%29=27&topic_id%28entry_subtopic_topic%29=3>.

[3] Ibid.

[4] "Schlumberger Oilfield Glossary: Terms beginning with 'S'. *Schlumberger Oilfield Glossary*. N.p., n.d. Web. (Accessed on January 18, 2011) <http://www.glossary.oilfield.slb.com/MainIndex.cfm?ID=19>.

collected crude oil samples from the BP Deepwater Horizon Mississippi Canyon Block 252 (MC-252 oil) on April 27, 2010. Analysis of the samples showed that the crude oil type spilled into the Gulf of Mexico is classified as "light sweet crude" a light sweet crude oil is a preferred form of petroleum because when refined, it yields a greater quantity of gasoline, kerosene, and other fuels.[5]

The EPA classifies crude oil based on characteristics such as toxicity, physical state, and changes in the oil due to weathering, which are the primary considerations in oil spill response. The EPA classification system for oils is relevant to all response personnel including those involved in remediation of historic resources after an oil spill.[6] EPA classification of oils is described below:

> **"Class A: Light, Volatile Oils.** These oils are highly fluid, often clear, spread rapidly on solid or water surfaces, have a strong odor, a high evaporation rate, and are usually flammable. They penetrate porous surfaces such as dirt and sand, and may be persistent in such a matrix. They do not tend to adhere to surfaces; flushing with water generally removes them. Class A oils may be highly toxic to humans, fish, and other biota. Most refined products and many of the highest quality light crudes can be included in this class.
>
> **Class B: Non-Sticky Oils.** These oils have a waxy or oily feel. Class B oils are less toxic and adhere more firmly to surfaces than Class A oils, although they can be removed from surfaces by vigorous flushing. As temperatures rise, their tendency to penetrate porous substrates increases and they can be persistent. Evaporation of volatiles may lead to a Class C or D residue. Medium to heavy paraffin-based oils fall into this class.
>
> **Class C: Heavy, Sticky Oils.** Class C oils are characteristically viscous, sticky or tarry, and brown or black. Flushing with water will not readily remove this material from surfaces, but the oil does not readily penetrate porous surfaces. The density of Class C oils may be near that of water and they often sink.

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[5] "Oil Spill Academic Task Force (OSATF)." *Oil Spill Academic Task Force (OSATF)*. N.p., n.d. (Accessed on January 21, 2011) "Description of the MC 252 Crude Oil" <http://oilspill.fsu.edu/images/pdfs/mc-252crude-oil-desc.pdf>.

[6] A historic resource contaminated by a fluid class C oil may require remediation approaches suited for a class D oil in the winter or in colder climates, when the class C oil solidifies due to low temperatures and resembles a class D oil.

Weathering or evaporation of volatiles may produce solid or tarry Class D oil. Toxicity is low, but wildlife can be smothered or drowned when contaminated. This class includes residual fuel oils and medium to heavy crudes.

Class D: Nonfluid Oils. Class D oils are relatively non-toxic, do not penetrate porous substrates, and are usually black or dark brown in color. When heated, Class D oils may melt and coat surfaces making cleanup very difficult. Residual oils, heavy crude oils, some high paraffin oils, and some weathered oils fall into this class.

These classifications are dynamic for spilled oils; weather conditions and water temperature greatly influence the behavior of oil and refined petroleum products in the environment. For example, as volatiles evaporate from a Class B oil, it may become a Class C oil. If a significant temperature drop occurs (e.g., at night), a Class C oil may solidify and resemble a Class D oil. Upon warming, the Class D oil may revert back to a Class C oil."[7]

2.2 National Contingency Plan and Oil Spill Remediation

The first NCP was developed by the Federal Government in 1968 in order to avoid problems such as those faced by English response officials after an oil spill near England in 1967. The NCP serves as the Federal Government's plan for responding to oil spills and hazardous substance releases and since 1968, is revised periodically to incorporate additional responsibilities and legislative changes.[8] In Subpart J, the NCP also establishes the NCP Product Schedule (Product Schedule), which lists chemical or biological products that may be used in the remediation of oil spills and hazardous substances; the EPA prepares and maintains the Product Schedule.[9] Emergency response personnel on-site, led by the EPA and Federal On-Scene Coordinator (FOSC), authorize the use of products listed in the Product Schedule.

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[7] "Types of Crude Oil" Emergency Management, EPA (Accessed on February 18, 2011) <http://www.epa.gov/oem/content/learning/crude.htm>.

[8] "National Oil and Hazardous Substances Pollution Contingency Plan Overview" Emergency Management, EPA. (Accessed on March 4, 2011) <http://www.epa.gov/oem/content/lawsregs/ncpover.htm>.

[9] "Subpart J: The National Oil and Hazardous Substances Pollution Contingency Plan (NCP) Product Schedule" NCP Factsheet, (Accessed on March 9, 2011) <http://www.epa.gov/oem/docs/oil/ncp/NCPfactsheet.pd>.

In response to an oil spill or a hazardous substance release, the Product Schedule may be updated to incorporate products suitable for use in remediation as they become available. Per Title 40, CFR 300, oil spill remediation agents are added to the Product Schedule after EPA review of specific data provided by the manufacturer, including recommended application procedures, concentrations, conditions of use including application restrictions, product effectiveness, and toxicity tests.[10]

2.3 Cleaning Agents for Crude Oil

The NCP Product Schedule lists four classes of oil spill remediation agents summarized below:[11]

Bioremediation Agents

Bioremediation agents include microbes, nutrients, enzymes, individually or in a combination intended to encourage the degradation of oil. Bioremediation agents are deliberately introduced into an oil spill to significantly increase the rate of biodegradation of oil, and do not include naturally occurring biological organisms that can degrade oil.

Dispersants

Dispersants are used to break up oil on the water's surface, subsequently causing it to disperse down into the water column where natural processes can degrade the oil droplets.

Surface Washing Agents

Surface Washing Agents (SWA) are used on solid surfaces to lift and float oil through a detergency mechanism that facilitates absorption, vacuuming or collection of oil. SWA do not disperse or solubilize the oil. In June 2011, the NCP Product Schedule listed 49 SWA, the maximum of any product category.[12]

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[10] "NCP Subpart J - Product Schedule | Emergency Management | US EPA." *US Environmental Protection Agency*. N.p., n.d. Web. (Accessed on April 1, 2011. <http://www.epa.gov/oem/content/ncp/index.htm>.
[11] "NCP Subpart J - NCP Definitions | Emergency Management | US EPA." *US Environmental Protection Agency*. N.p., n.d. Web. (Accessed on April 1, 2011) <http://www.epa.gov/oem/content/ncp/index.htm>.
[12] "Guide to Using the NCP Product Schedule Notebook" US EPA. (Accessed on March 7, 2011) <http://www.epa.gov/oem/docs/oil/ncp/notebook.pdf>.

Miscellaneous Oil Spill Control Agents (MOSCA)

MOSCA includes chemical based sorbents and solidifiers, and products other than those listed in the above categories, used during oil spill mitigation.

2.4 Focus on Surface Washing Agents

After the BP oil spill, at the request of the Louisiana SHPO and Louisiana Office of State Parks, in June 2010 two staff members from NCPTT visited Fort Livingston to assess the amount of oil contamination on the Fort, to conduct cleaning trials on selected areas of the Fort, and to collect samples of oil, contaminated water, and sand. Cleaning trials were conducted using a poultice of attapulgite clay (clay) and mineral spirits, and a series of VeruTEK products, to evaluate their effectiveness in removing weathered crude oil from the brick masonry at the Fort.[13] At the time of the site visit, none of the products tested were on the NCP Product Schedule.

After the visit to the Fort by NCPTT staff, Dr. Jacqueline Michel[14] who was the NOAA coordinator for the shoreline cleanup and assessment teams (SCAT) in the region, contacted NCPTT and recommended the evaluation of SWA rather than other classes of cleaners, to clean oil contamination from the Fort. According to Dr. Michel, SWA are effective cleaners; however, due to limited and difficult to understand information available on the effectiveness of SWA, and few documented case histories of SWA use for oil spill remediation, Regional Response Teams (RRT) do not frequently recommend SWA for oil spill remediation.[15]

In September 2010, NCPTT staff members and the author of this report made a visit to the Fort. During this site visit, based on Dr. Michel's recommendation, NCPTT evaluated eight cleaners. Two out of the eight cleaners tested were on the NCP Product Schedule; a poultice of clay and a solvent-based cleaner was also tested. Based on visual assessment, a few of the cleaners tested successfully removed 50 to 70% of soiling from the brick surface; however, none of the products removed 100% of the soiling. After evaluating results from cleaning tests

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[13] Chin, Carol. " Ft. Livingston Grand Terre Island Field Report." *NCPTT | National Center for Preservation Technology & Training | National Park Service*. N.p., n.d. Web. (Accessed on October 12, 2010) <http://www.ncptt.nps.gov/>.

[14] Dr. Jacqueline Michel is a geochemist specializing in terrestrial and marine pollution studies, coastal geomorphology, and environmental impact assessments. She is the President of Research Planning, Inc. (RPI) since 2000. She has been on the National Oceanic and Atmospheric Administration Scientific Support Team since 1978, and has field-tested surface-washing agents for use in shoreline oil clean-up.

[15] Michel, Jacqueline, Ann Hayward Walker, Debra Scholz, and John Boyd. "Surface-washing agents: Product evaluations, case histories, and guidelines for use in marine and freshwater habitats." *Proceedings of the 2001 International Oil Spill Conference* (2001): 805-813.

conducted during each visit, NCPTT recommended additional testing of SWA to identify those best suited for removing weathered crude oil from the brick at the Fort.[16]

[16] Chin, Carol. " Field Report: Fort Livingston, Grand Terre Island." *NCPTT | National Center for Preservation Technology & Training | National Park Service*. N.p., n.d. Web. (Accessed on March 9, 2011) <http://www.ncptt.nps.gov/>.

Chapter 3: Sample Preparation Methodology

Experimental design and methods developed for soiling and artificially weathering brick samples are presented in this Chapter. The process of cleaner selection and evaluation methodology are presented in Chapter 4.

3.1 Experimental Design and Related Constraints

The unprecedented scale of the oil spill, weathering of crude oil on the masonry at the Fort, remote offshore location in a sensitive marine environment, and related restrictions on materials and methods of remediation necessitated the development of an experimental design, which addressed the unusual site conditions. Federal regulations prohibit the removal of oil-contaminated (soiled) brick from the Fort, which is a designated historic structure.[1] Due to limited information on laboratory soiling of brick samples, a controlled and reproducible method was developed to recreate brick at the Fort that are soiled with weathered crude oil deposited over the course of twelve months.

Limited available information on methods to remove crude oil from historic masonry also necessitated the development of a method for cleaning soiled brick samples in the laboratory. The experimental design is shown in Appendix A. The methodology for this study consisted of the following:

- Preparation of brick samples
- Selection of artificial weathering parameters
- Selection of a method to deposit soiling on brick samples
- Pre-treatment of weathered crude oil
- Soiling evaluation
- Cleaning methodology for evaluating selected SWA

As shown in Appendix A, changes in the visual appearance of samples were evaluated at every stage of the study. In order to avoid disturbing the sample surface after soiling and weathering, the choice of evaluation methods was limited to non-contact and non-destructive

[1] Federal regulations such as the Archeological Resources Protection Act (ARPA) prohibit the removal of artifacts from archeological sites and historic properties.

methods. Visual evaluation by survey participants and telecolorimetry (non-contact colorimetry) were selected as the methods of evaluation in this study, and are further discussed in Chapter 5.

3.2 Preparation of Brick Samples

The following series of brick samples were prepared for laboratory evaluation of selected SWA:

- Q series – soiled, artificially weathered samples
- U series – soiled, unweathered samples[2]

Prior to soiling and weathering, the samples were cut, conditioned, and prepared for soiling as described below.

3.2.1 Sample Cutting

NCPTT used standard sized[3] brick from an exterior chimney of an early 20th century house in Cloutierville, Louisiana to cut samples used for this study. The samples were cut using a Buehler trim saw with a 10 inch, water-cooled diamond blade, and were prepared by cutting along the sides of each brick. Each side was further cut into 3-3/4 x 2-1/2 x 1/2 inch samples (Figure 3.1).[4] The cut samples were dried overnight at 100°F at the NCPTT laboratories before being sent to UT-Austin for use in cleaner evaluation.

As shown in Figure 3.2 and Figure 3.3, each sample had a cut surface and a fired surface. For this study, the cut surface of the samples was soiled because the uneven surface of the fired side would result in uneven soiling of samples, and affect the results of cleaner evaluations.

3.2.2 Sample Conditioning

The brick samples were conditioned in accordance with ASTM C67-09 *Standard Test Methods for Sampling and Testing Brick and Structural Clay Tile*. The samples were soaked in

[2] Although remedial action on historic masonry within 24 hours of oil contamination is unlikely, the series of unweathered samples was evaluated for comparison with the weathered series and to develop a better understanding of the effect of immediate remedial action after oil contamination.

[3] The standard nominal size of 19th century brick is 3-3/4 x 2-1/4 x 8 inch.

[4] The sample size was determined by the maximum size of samples that can be placed in the artificial weathering chamber.

tap water for 24 hours, dried at 230°F, then weighed. Percent water absorption of each brick sample was calculated from the weights recorded as a part of conditioning (Appendix A).[5]

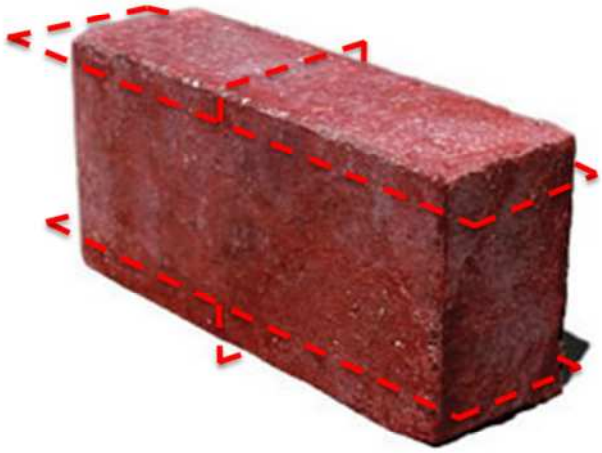

Figure 3.1: Schematic diagram of brick samples cut for this study

[5] Samples were conditioned and soiled at the UT-Austin laboratories.

Figure 3.2: The cut surface of a brick sample used in this study

Figure 3.3: The fired surface of typical brick samples used in this study. Note: the striped marks on the brick are from the rack on which the brick samples were soaked in saline solution. The white areas are efflorescence after soaking the brick in a 3.2% saline solution for 24 hours.

3.2.3 Preparation of Samples for Soiling

The oil contaminated brick at the Fort have been saturated with seawater since the mid-19th century. Absorption of crude oil on water-saturated brick may be different from that on dry brick. Therefore, in the laboratory, prior to soiling with oil, the brick samples were saturated by soaking in saline solution for 24 hours. The saline solution was made by mixing sea salt with tap water, to achieve a salinity of approximately 3.4% (34 ppt); the reported average salinity in the Gulf of Mexico is between 3.2% (32 ppt) and 3.6% (36 ppt).[6] In order to minimize evaporation of water from samples during soiling, the soaked samples were kept in the saline solution and each sample was removed as needed for soiling. The surface of each sample was blotted dry prior to soiling.

3.3 Artificial Weathering[7]

The contaminated brick at the Fort are weathered by cyclical exposure to ultra-violet (UV) radiation, humidity, varying degrees of sun and shade, and direct contact with seawater and oil during high tide. These natural weathering parameters and cycles cannot be replicated in the laboratory accurately and within a reasonable period of time; however, artificial weathering can be used to simulate conditions that reasonably represent the effects of natural weathering. For this study, the soiled brick samples were artificially weathered using an Atlas Ci4000 Xenon Arc Weather-Ometer (WOM)[8] in accordance with Cycle 1 of the ASTM G155-05 *Standard Practice for Operating Xenon Arc Light Apparatus for Exposure of Non-Metallic Materials*. Exposure parameters for Cycle 1 are 102 minutes light at 63°C (145.4°F) black panel temperature, followed by 18 minutes light and water spray.

The samples were vertically oriented in the WOM. The sample rack and typical arrangement of samples in the WOM are shown in Figure 3.4 and Figure 3.5.

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6 "COAST - Physical Parameters Activities - Creating and Comparing Various Saline Environments within the Gulf of Mexico." *Welcome to COAST*. N.p., n.d. Web. (Accessed on March 28, 2011) <http://www.coast-nopp.org/resource_guide/elem_mid_school/physical_param_acts/saline.html>.

7 The method of artificial weathering used in this study is described prior to oil dilution and soiling because artificial weathering was used for preliminary evaluation of soiling and weathering during the development of soiling methodology.

8 "Products | Atlas - Weathering | Home / Products." *Atlas - A Global Leader in Weathering Technology & Equipment*. N.p., n.d. Web. (Accessed on March 9, 2011) <http://weather-ometer.com/standardsdb/standards_products?item_id=10568>.

Figure 3.4: Empty sample rack in the WOM

Figure 3.5: Typical arrangement of soiled samples in the WOM

3.4 Method for Soiling Samples[9]: Drawdown

The cut surface of each brick sample was soiled using a drawdown method typically used in the paints and coatings industry. In the drawdown method, a surface is coated with a specific quantity of material using a tool such as an eight-path applicator, a drawdown bar, or a rod. The tool may have one gap for a coating of a certain thickness, or a series of gaps that allow coatings of various thicknesses to be applied to a surface. The tool coats the surface with material in a layer of uniform thickness determined by the gap and viscosity of the coating material.

For this study, the drawdown method was determined to be the most controlled way of depositing a specific quantity of oil onto each brick sample in a layer of uniform thickness. A Precision Gage & Tool Company (P.G. & T. Co.) #24 eight-path drawdown applicator[10] (drawdown tool) shown in Figure 3.6 was used for soiling brick samples. Soiling trials were conducted as described in Section 3.5, to optimize the thickness of the oil layer coated on the brick samples. A consistent and uniform layer of oil on each brick sample was necessary in order to comparably evaluate cleaner effectiveness within each set of samples and between sample sets.

Figure 3.6: P.G. & T. Company eight-path applicator used to soil samples

[9] The soiling method used in this study is described prior to oil dilution because this method was used to soil samples for preliminary evaluation of oil dilution methods.

[10] "Precision Gage & Tool-Dayton, Ohio." *Precision Gage & Tool-Dayton, Ohio*. N.p., n.d. Web. (Accessed on March 6, 2011) <http://www.pgtgage.com/GrndGage.pdf>.

Figure 3.7: Drawdown tool being used to coat brick

3.5 Pre-treatment of Weathered Crude Oil and Soiling Evaluation

Weathered MC-252 crude oil collected from Grand Terre Island during a site visit in September 2010 was used to soil the brick samples evaluated in this study (Figure 3.8). At ambient temperature (between 68°F and 74°F), the weathered crude oil collected from the Fort was thick and viscous, with the consistency of cold peanut butter (Figure 3.9). As a result the oil could not be used for soiling the brick surface without being pre-treated in order to lower the viscosity. The following methods were evaluated:

- High shear mixing
- Heating
- Dilution with odorless mineral spirits

Figure 3.8: Weathered crude oil being collected at Fort Livingston

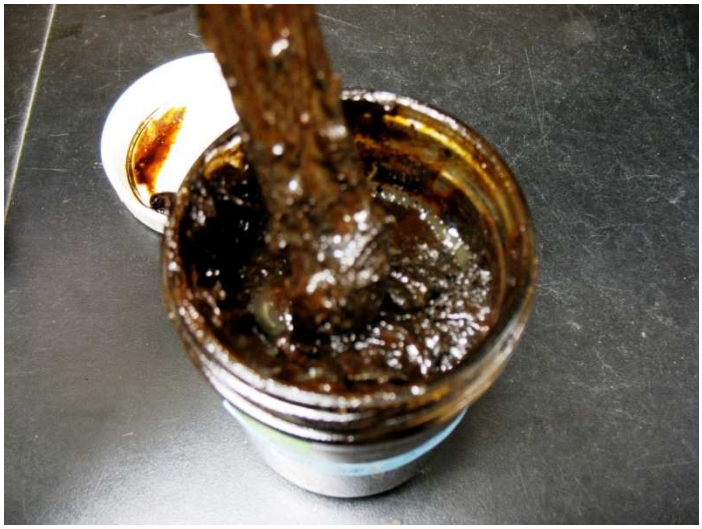

Figure 3.9: Weathered crude oil collected from Fort Livingston in September 2010.

Three approaches described below were evaluated to lower the viscosity of the oil before using the oil to soil brick samples. Results of preliminary soiling evaluations using oil described

in each approach are also presented here.[11] Samples were soiled using the drawdown method and eight-path applicator described in Section 3.3.

High Shear Mixing

Oil and water were heated in separate containers at 90°F. A mixture with 1:5 water-to-oil ratio was made by adding the heated water to the heated oil and mixing using a Silverson L4R high shear mixer (Figure 3.10).

Figure 3.10: Oil and water being mixed with a high shear mixer

[11] Since a limited number of brick samples were available for this study, initial trials during the development of soiling methodology were conducted on brick samples that broke during transportation from NCPTT to UT-Austin.

Mixing the oil and water in a high shear mixer was not a feasible approach for lowering the viscosity of the oil to soil brick samples because the oil remained separate from the water and most of the oil remained stuck to the mixer blade and the container, as shown in Figure 3.11. Additionally, high shear mixing did not lower the viscosity of the oil enough to allow uniform application of oil on the brick surface (Figure 3.12).

Figure 3.11: Oil and water after mixing with a high shear mixer

Figure 3.12: Oil collected after being mixed in a high shear mixer for 5 minutes

Heating

Undiluted oil heated to 90°F in the oven was evaluated as an option for soiling.[12] Heating undiluted oil at 90°F lowered the viscosity of the oil; however, as the oil cooled, it regained viscosity within 5 minutes of being removed from the oven. Increased viscosity due to a decrease in oil temperature would likely result in uneven soiling on the brick samples.

A total of five brick samples were soiled with the heated undiluted oil in order to verify that heated undiluted oil would cool too fast to allow uniform soiling. Two different coating thicknesses were also evaluated. One sample was soiled using the 0.050 inch (50 mil) gap on the applicator, and four samples were soiled using the 0.025 inch (25 mil) gap on the same applicator.[13] According to the manufacturer, the 50 mil gap results in the coating thickness of 25 mil, and the 25 mil gap results in a coating thickness of 12.5 mil.[14]

[12] Oil was not heated at a higher temperature because heating oil above 90°F would likely change the composition of oil.

[13] The 25 mil drawdown gap was selected as a starting point for soiling trials based on input from coatings engineers at TxDOT laboratories. Soiling evaluation using the 50 mil gap was conducted in order to verify that the 50 mil gap would result in a thick coating of oil, not feasible for use in soiling brick samples.

[14] http://www.pgtgage.com/GrndGage.pdf.

As noted in Section 3.3, the soiled samples would be vertically oriented in the WOM for the duration of artificial weathering. Any loss of oil from the sample surface due to slump during artificial weathering would lead to inconsistent results. Therefore, all soiled samples were placed in the vertical position for five minutes at ambient temperature to check for slump, in order to select an optimal coating thickness. As shown in Figure 3.13, oil slumped off the surface of the sample coated with the 50 mil gap at ambient temperature, indicating an excessive quantity of oil on the sample surface. No slump was observed at ambient temperature on the four samples soiled with the 25 mil gap. The soiled samples were subsequently placed in a 77°F oven to check the wet flow (slump) in accordance with test number 19 of ASTM D2939-03 *Standard Test Methods for Emulsified Bitumens Used as Protective Coatings*.[15]

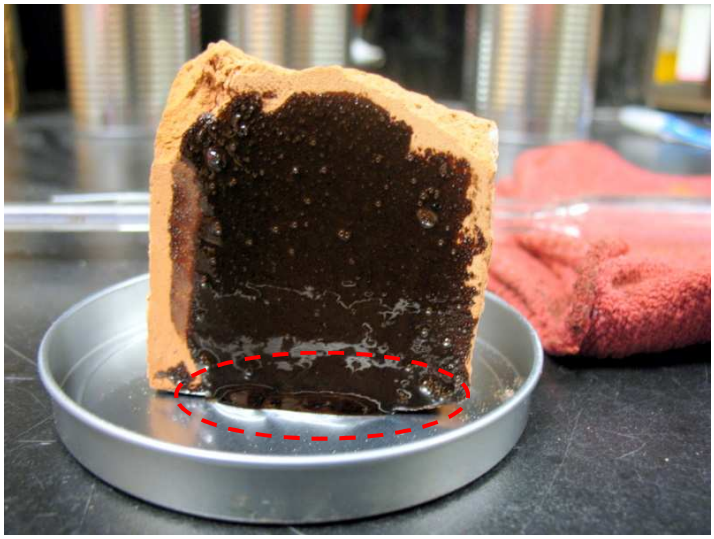

Figure 3.13: Sample soiled with 50 mil gap showing oil slump at ambient temperature

As shown in Figure 3.14, during the wet flow test, a significant quantity of oil slumped off the surface of each sample. Heating undiluted oil to 90°F does not appear to provide enough

[15] The sample soiled using the 50 mil gap, from which oil slumped at ambient temperature, was also placed in the oven for a slump test in order to observe any additional slump of oil from the sample surface.

flow for the oil to be deposited in a uniform layer on the brick. As a result, the excess oil slumps from the brick surface when the samples are vertically oriented and exposed to heat.

Additionally, due to a variation in the soiling thickness on each sample coated with heated undiluted oil, the loss of oil from the sample surface due to slump would also vary from sample to sample, resulting in an inconsistent quantity of oil left on each sample. This would affect the consistency of results of cleaning evaluations and subsequent analytical techniques used to evaluate and compare the efficacy of selected cleaners. Therefore, heated oil was not feasible for soiling brick samples in this study.

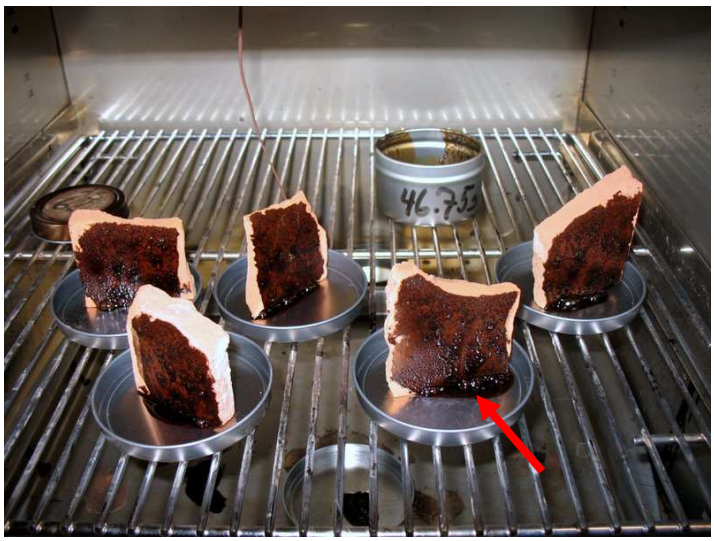

Figure 3.14: Undiluted heated oil slumped off from samples during the wet flow test. Note: the arrow shows the sample soiled using the 50 mil gap, from which oil slumped at ambient temperature.

Dilution with Odorless Mineral Spirits

Odorless mineral spirits (OMS) was added in 1 mL increments to the collected known mass of oil, until the oil appeared to be diluted for even application on brick samples. A mixture containing 25% OMS and 75% oil (by weight) appeared to have a low enough viscosity to conduct preliminary soiling evaluation (Figure 3.15). Five samples were soiled with this mixture

using the 25 mil gap and weathered in the WOM for over twelve hours in accordance with ASTM G155 Cycle 1 to observe any loss of oil from the brick surface due to slump (Figure 3.16 and Figure 3.17).

Figure 3.15: Mixture containing 25% mineral spirits and 75% oil

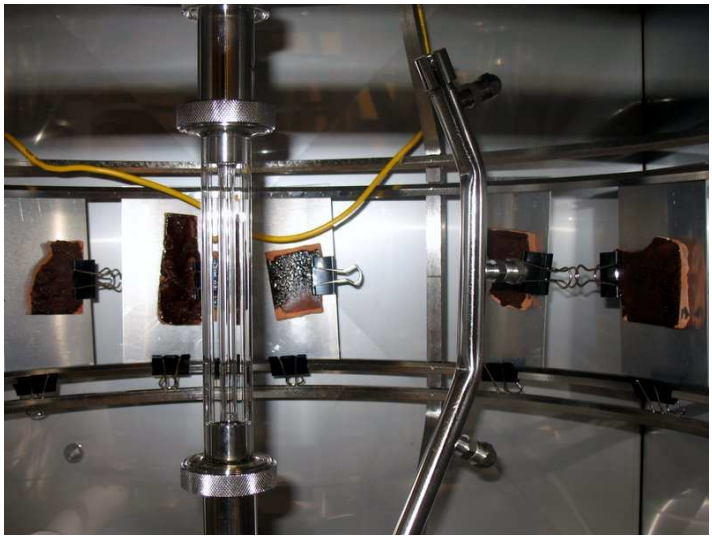

Figure 3.16: Samples in the WOM, prior to weathering

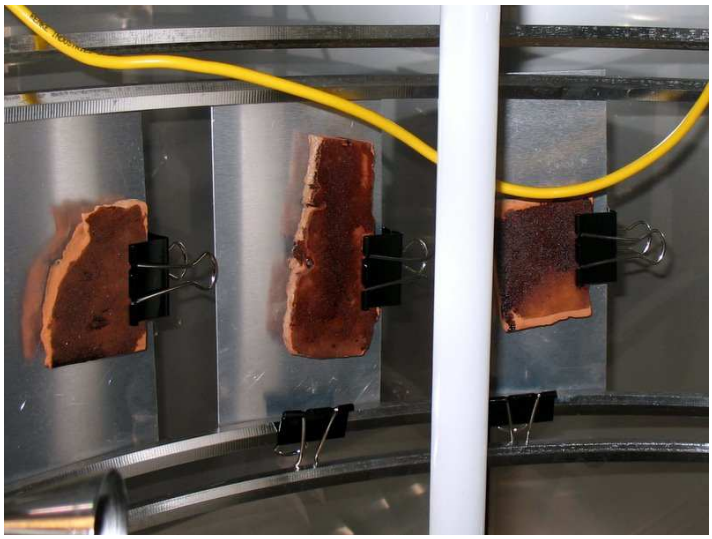

Figure 3.17: Samples in the WOM after weathering for 12 hours

Although no dripping or slump was observed during the initial weathering trials on samples soiled with a mixture of 25% OMS and 75% oil, 25% OMS excessively lowered the

viscosity of the oil, causing the oil to drip down the edge of the sample during drawdown of oil on the sample surface (Figure 3.18). A mixture containing the optimal quantity of OMS to enable uniform soiling of samples would ensure enough oil on the sample surface to be able to clearly identify the cleaners that would effectively remove the maximum quantity of oil from the brick surface.

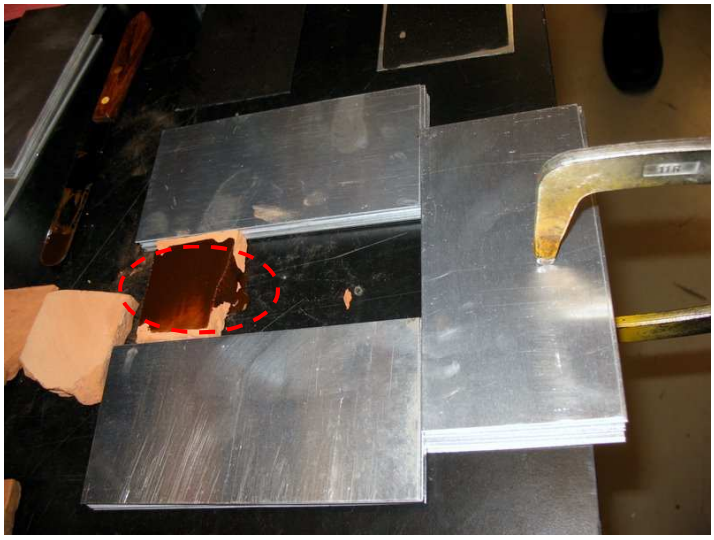

Figure 3.18: Sample after drawdown using the 25 mil gap and a mixture containing 75% oil and 25% mineral spirits. Note: the light and dark coated areas indicate that the oil coating is not uniform due to variations in the brick surface. Oil is seen dripping from the edge of the sample after drawdown.

Based on the above results, soiling trials using mixtures with 5, 10, and 15% OMS content were conducted to determine the optimal amount of OMS in a mixture. A mixture containing 5% OMS and 95% oil was too viscous to uniformly coat oil on the sample. Additionally, as OMS evaporated from the mixture while a series of samples was being soiled, the mixture became viscous and difficult to coat on the samples. A mixture containing 15% OMS and 85% oil had very low viscosity and resulted in dripping off the sample edge during drawdown.

A mixture containing 90% oil and 10% OMS appeared to uniformly coat the sample surface without dripping, and did not regain viscosity during the duration of soiling a series of samples. Based on these results, a mixture containing 90% oil and 10% OMS was determined to be optimal for soiling. All subsequent samples for this study were soiled using a mixture containing 90% oil and 10% mineral spirits.[16]

[16] As shown in Figure 3.18, the oil and mineral spirits mixture was not uniformly coated on the brick surface due to variations in the surface of the brick. This condition was inevitable in this study due to slight variations in the cut surfaces of each brick sample. However, the slight non-uniformity of the sample surface is not likely to significantly affect the results of cleaner evaluations.

Chapter 4: Selection of Surface Washing Agents

The process for selecting six SWA (cleaner) for evaluation on the Q and U series of soiled brick samples is presented in this Chapter. The method developed for cleaning the soiled samples is also presented here.

4.1 Selection of SWA for Preliminary Evaluation

The six SWA evaluated on soiled brick samples were selected as follows:

- Product data review and preliminary selection of SWA
- Evaluation of solvency of weathered crude oil using SWA
- Preliminary evaluation of cleaner effectiveness

4.1.1 Product Data Review and Preliminary Selection of SWA

As noted in Chapter 2, in accordance with Federal regulations, proprietary products considered for use during disaster mitigation are listed in one of the four categories of the NCP Product Schedule. Before a product is reviewed for listing on the Product Schedule, the EPA requires manufacturers to submit technical data pertaining to each product. Data requirements vary for each product category[1] and may include effectiveness testing. According to Subpart J of the NCP, technical data requirements submitted for SWA do not include results of effectiveness testing.[2,3] At the time of this study, over forty SWA and corresponding product data were listed on the Product Schedule. In accordance with EPA requirements, product data listed for each SWA include pH, recommended dilutions and procedures, conditions of use with application restrictions, and toxicity tests.

Based on review of product data including pH[4], composition, product dwell time[5], and ease of application[6], fourteen SWA listed on the NCP Product Schedule were determined to be

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[1] Product categories are: Bioremediation Agents, Dispersants, Surface Washing Agents (SWA), and Miscellaneous Oil Spill Control Agents (MOSCA).

[2] "NCP Subpart J - Product Schedule | Emergency Management | US EPA." *US Environmental Protection Agency*. N.p., n.d. Web. (Accessed April 22, 2011) <http://www.epa.gov/emergencies/docs/oil/cfr/900_920.pdf>.

[3] When reviewing products for use in an oil spill, RRTs may require effectiveness testing of all products including SWA, to address site-specific or area-specific concerns.

[4] pH-neutral products (or products with a pH close to neutral) were selected because highly acidic or alkaline products may have a deleterious effect on the brick.

[5] Products with long dwell times would not be feasible for use at the Fort due to tidal cycles.

suitable for laboratory evaluation. Availability of product samples, results of case precedents, and special considerations pertaining to the use of each product in removal of crude oil from masonry were also discussed with product manufacturers. Out of the fourteen SWA suitable for laboratory evaluation in this study, samples of the following twelve SWA were received from product manufacturers;[7] names of product manufacturers are given in parenthesis:

BioSolve (The Biosolve Company)

Clean Green Planet Wash (US Ag, LLC)

Cytosol Biosolvent (Cytoculture International, Inc.)

De-Solv-It Clean-Away All Purpose Cleaner (APC) Super Concentrate (Orange-Sol)

De-Solv-It Industrial Formula (Orange-Sol)

Environmental 1 (Environmental 1, LLC)

E-Safe (Plutus Environmental Technologies, Inc.)

GoldCrew (Environmental Chemical Solutions, Inc.)

Nale-It (SPL Control, LLC)

Petro-Clean (Alabaster Corporation)

Procleans PCR 107 (Eximco International, Inc.)

SC-1000 (Gemtek Products)

NCPTT staff evaluated De-Solv-It Cleaner, Goo Gone, and VeruSOLVE during field tests at Fort Livingston in 2010; however, no laboratory evaluations had been conducted on the cleaners.[8] Previous studies[9] indicate that d-limonene-based cleaners may be able to remove crude oil from masonry in marine locations. Therefore, in addition to the above SWA selected from the NCP Product Schedule, the following four cleaners[10] were included in the preliminary evaluation:

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[6] Grand Terre Island does not have docking facilities, waste disposal, electricity, or availability of fresh water. Products that require fresh water or specialized equipment for application or effluent collection may not be feasible for use at the Fort.

[7] Samples of Corexit EC9580A and Nokomis 5-W were requested but not received from the manufacturer.

[8] Chin, Carol. "Field Report: Fort Livingston, Grand Terre Island." *NCPTT | National Center for Preservation Technology & Training | National Park Service*. N.p., n.d. Web. (Accessed on March 9, 2011) <http://www.ncptt.nps.gov/>.

[9] Michel, Jacqueline, Ann Hayward Walker, Debra Scholz, and John Boyd. "Surface-washing agents: Product evaluations, case histories, and guidelines for use in marine and freshwater habitats." *Proceedings of the 2001 International Oil Spill Conference* 0 (2001): 805-813. Print.

[10] At the time of the evaluation, VeruSOLVE, De-Solv-It Cleaner, Goo Gone, and GreenTerpene d-limonene were not listed on the NCP Product Schedule.

De-Solv-It Cleaner

Goo Gone

GreenTerpene d-limonene

VeruSOLVE

4.1.2 Interaction between Selected SWA and MC-252 Weathered Crude Oil

In response to the unprecedented BP oil spill, numerous SWA were added to the Product Schedule: in 2001, fourteen SWA were listed on the Product Schedule[11]; in March 2011, forty six SWA were listed, and in June 2011, forty nine SWA were listed on the Product Schedule. Based on discussions with product manufacturers, the SWA selected for this study have not been evaluated or used for removing weathered crude oil from masonry. Therefore, in this study, the interaction between each of the selected SWA and MC-252 weathered crude oil was evaluated prior to testing SWA on soiled brick samples.

Preliminary evaluation of each SWA was done by manually agitating for approximately 30 seconds, a small quantity of oil ($\leq$ 1.5 g) with approximately 4 ml of undiluted (neat) cleaner in a vial or test-tube. The mixture was allowed to dwell for 24 hours prior to making observations regarding the interaction between the oil and cleaner.

Results

The d-limonene-based solvent cleaners including De-Solv-It Industrial Formula, GreenTerpene, and Goo Gone dissolved the oil fastest, within less than 15 minutes of agitation. Cytosol dissolved oil within 2 hours. Other cleaners reacted more slowly, but were effective at dissolving the oil. Some cleaners including Environmental 1, VeruSOLVE, and Nale-It did not dissolve the oil even after 24 hours.

[11] Michel, Jacqueline, et al. "Surface-washing agents: Product evaluations, case histories, and guidelines for use in marine and freshwater habitats." *Proceedings of the 2001 International Oil Spill Conference*

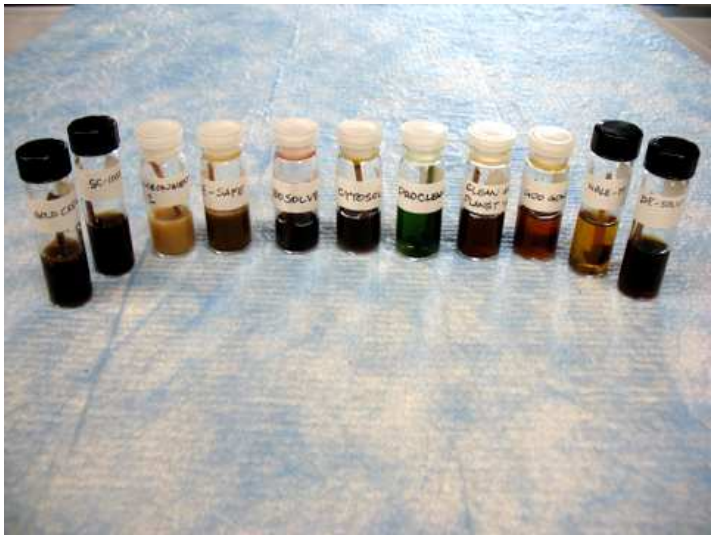

Figure 4.1: Cleaners and oil after agitation, showing cleaners that dissolved oil within 15 minutes to 24 hours

Discussion

Based on the above results, SWA that dissolved oil within a 24-hour period were selected for further evaluation on soiled brick samples. Based on the results of evaluation on soiled brick samples, six SWA were selected for final evaluation on weathered and unweathered soiled samples. For the preliminary evaluation of cleaner and oil interaction, all SWA were used neat and allowed to dwell for 24 hours in a vial, as described in Chapter 3. SWA that did not interact with oil during this evaluation would likely not remove oil from the soiled brick samples after being diluted, and were excluded from further evaluation. Products tested by NCPTT during field trials were included in the preliminary laboratory evaluation in order to observe product interaction with oil; however, they were excluded from further evaluation because they were not listed on the NCP Product Schedule.

Although all oil and SWA mixtures were allowed to dwell for 24 hours, the nine SWA listed below dissolved approximately 90% of the oil within 6 hours. The SWA are listed in order of those with a high rate of oil dissolution to those with a low rate of oil dissolution.

De-Solv-It Industrial Formula

BioSolve

Clean Green Planet Wash

Cytosol Biosolvent

De-Solv-It Clean-Away APC Super Concentrate

E-Safe

GoldCrew

Petro-Clean

SC-1000

4.2 Development of the Cleaning Method

The cleaners were diluted as shown in Table 4.1 below; each sample was held in the vertical position while cleaning. The sample was pre-wet by spraying 3.4% saline solution until the sample surface appeared saturated with water. Cleaner was sprayed on the soiled surface of the brick sample until the surface appeared to be covered with the cleaner. The cleaner was allowed to dwell on the sample surface for the duration listed in Table 4.1, with additional treatment (such as spraying with water or dilute cleaner) as specified by the manufacturer. The cleaner on the sample surface was manually agitated with a nylon soft-bristle brush using medium pressure and circular motion. Agitation was done in 15-second intervals, for a total of 60 seconds.

After the first 15-second agitation, the sample surface was sprayed with the cleaner, followed by a second 15-second agitation. After subsequent intervals, if the sample surface was dry and the cleaner on the surface was difficult to agitate, saline solution was sprayed as required to enable agitation. After the last 15-second agitation, cleaner residue and loose soiling were rinsed from the sample by generously spraying saline solution on the sample surface. The sample was placed horizontally on a wire rack to dry at room temperature for at least 24 hours prior to making observations.

4.3 Selection of Six SWA for Evaluation on Q and U Series Soiled Brick Samples

The nine SWA selected based on interaction with oil as described above are listed in Table 4.1. The product data listed in Table 4.1 are published in the NCP Product Schedule; cleaning guidelines and special considerations during cleaning are also published in the Product Schedule and are summarized in the Notes column.

The cleaners were evaluated using three soiled, unweathered brick samples per cleaner, for a total of twenty-seven brick samples. The samples were conditioned, soaked in saline

solution for 24 hours, and soiled as described in Chapter 3. The samples were cleaned using the method described in Section 4.2.

SWA	Ingredients	Solubility in Water	pH	Toxicity, LC50 ppm (silverside 96-hr; shrimp 48-hr)	Dilution	Minimum Dwell Time	Notes
Petro-Clean	Mixture of water, Emulsifiers, Surfactants, Dispersants, naturally occuring micro-organisms (non-pathogenic).	100%	7.0 - 8.0 (EPA: 8.05 (10% soln))	100 96-hr; 110 48-hr	6%	≥ 45 min.	Dwell, agitate, rinse
CytoSol Biosolvent	Proprietary formulation of soy oil methyl esters and bioremediation enhancers.	7 ppm in sea water	Neutral	738 96-hr; 124 48-hr	Neat	1 h.	Dwell, agitate, rinse
SAFE CARE SC-1000	Non-ionic surfactants and seed ester alcohols.	99.94%	10.2 - 10.5	26.40 96-hr; 15.20 48-hr	EPA: 20%, Mfr.: Neat for heavy soiling	1 h.	Dwell, agitate, rinse
GoldCrew	Proprietary blend of surfactants.	100%	9.76 ± 0.01	13.80 96-hr; 20.40 48-hr	20%	1 h. with 20% solution	Dwell, spray with 5% solution, agitate, rinse
De-Solv-It Clean-Away APC Super Concentrate	D-limonene. Biodegradable.	100%	9 - 9.5	20.95 96-hr; 30.95 48-hr	1:1	~ 15 min.	Dwell, agitate, rinse. Spray more product before agitation if required.
De-Solv-It Industrial Formula	D-limonene, non-ionic proprietary surfactants and solvents. Biodegradable.	None. Miscible in oil and solvents	None (EPA: 6.6)		Neat	~ 15 min.	Dwell, agitate, rinse. Spray more product before agitation if required.

Table 4.1: Selected Surface Washing Agents (SWA). The SWA were evaluated in order to select six SWA for final evaluation. Note: cleaning guidelines and special considerations based on manufacturers' recommendations are summarized in the Notes column above.

BioSolve	Water Based, Biodegradable, Wetting Agents & Surfactants.	100%	9.1 ± 0.3 (EPA: 9.37 ± 0.5)	6.4 96-hr; 3.6 48-hr	6%	No recommended dwell time because according to manufacturer, the product reacts instantaneously.	Dosage is very important so make sure to thoroughly cover area with ample amount of product.
E-Safe	Proprietary blend of surfactants and organic solvents in aqueous solution; Contains 2 ppm Floresin and 2 ppm Orcoacid Orltofast Turq for identification.	Infinite	8.04	329.0 96-hr; 257.0 48-hr	Neat	Until product is no longer visible on surface	Spray product then soak surface with water to enhance product action on oil.
Clean Green Planet Wash	Proprietary blend of surfactants, additives, and solvents.	Miscible in oil, water, and solvents	9.9	136.10-hr; 70.70-hr	1:10	Mfr. is not sure, try various dwell times up to 24 hours	Dwell, agitate, rinse

Table 4.1, cont.

Results and Discussion

Figure 4.2 and Figure 4.3 show the brick samples after one cleaning cycle.[12] Cytosol and De-Solv-It Industrial Formula appear to have removed the maximum amount of surface soiling during the first cleaning cycle; BioSolve and E-Safe appear to have removed the least amount of surface soiling from the brick samples. Based on the results of the first cleaning cycle, the cleaners can be ranked in the following order, from highest to lowest cleaning effectiveness:

Cytosol
De-Solv-It Industrial Formula
De-Solv-It APC Super Concentrate
SC-1000
Petro-Clean

[12] At the time of the first cleaning cycle, detailed product data and application recommendations for Clean Green Planet Wash were unavailable from the manufacturer or the NCP Product Schedule. Therefore, Clean Green Planet Wash was evaluated later.

GoldCrew

Clean Green Planet Wash

BioSolve

E-Safe

Figure 4.2: Bricks after the first cleaning cycle with 1. Petro-Clean, 2 Cytosol, 3. SC-1000, 4. GoldCrew, 5. De-Solv-It Clean Away APC Super Concentrate, and 6. De-Solv-It Industrial Formula

Figure 4.3: Bricks after the first cleaning cycle with 7. BioSolve and 8. E-Safe. Note: Clean Green Planet Wash was evaluated later.

A second cleaning cycle was performed with the seven cleaners listed below, in order to evaluate the results of re-application of each cleaner. Cytosol and De-Solv-It Industrial Formula appeared to have removed all surface soiling in the first cleaning cycle and were not included in the second cleaning cycle. The dwell time and cleaning method for each cleaner were the same as for the first cleaning cycle. The results of the second cleaning cycle are shown in Figure 4.4 and Figure 4.5.

De-Solv-It APC Super Concentrate

SC-1000

Petro-Clean

GoldCrew

Clean Green Planet Wash

BioSolve

E-Safe

Figure 4.4: Brick samples after the second cleaning cycle with 1. Petro-Clean, 3. SC-1000, 4. GoldCrew, and 5. De-Solv-It Clean Away APC Super Concentrate

Figure 4.5: Brick samples after the second cleaning cycle with 7. BioSolve, 8. E-Safe, and 9. Clean Green Planet Wash

Cytosol and De-Solv-It Industrial Formula appeared to have cleaned the brick with the highest effectiveness of all nine cleaners evaluated, and required one cleaning cycle. Clean Green Planet Wash appeared to have performed well however soiling was removed from the sample surface inconsistently and in patches. Although the patches where soiling was removed by Clean Green Planet Wash appeared to have minimal residue of oil, the cleaner may yield uneven results and may be difficult to use in the field. The other cleaners performed with varying degrees of success.

Based on the results of the cleaning evaluations described above, the following six SWA, listed in order of performance, were selected for evaluation on the soiled, weathered Q series and soiled, unweathered U series samples:

Cytosol
De-Solv-It Industrial Formula
De-Solv-It APC Super Concentrate
SC-1000
Petro-Clean
GoldCrew

Chapter 5: SWA Evaluation

5.1 Unweathered and Artificially Weathered Samples Prepared for Evaluation of Cleaner Effectiveness

Six selected cleaners were evaluated on a total of seventy-two samples including controls, as shown in Figure 5.1. Q series samples were artificially weathered (weathered) for 720 hours in a WOM. The U series samples were not weathered; however, the soiled samples were placed in an oven at 100°F for 12 hours to evaporate mineral spirits from the sample surface.[1]

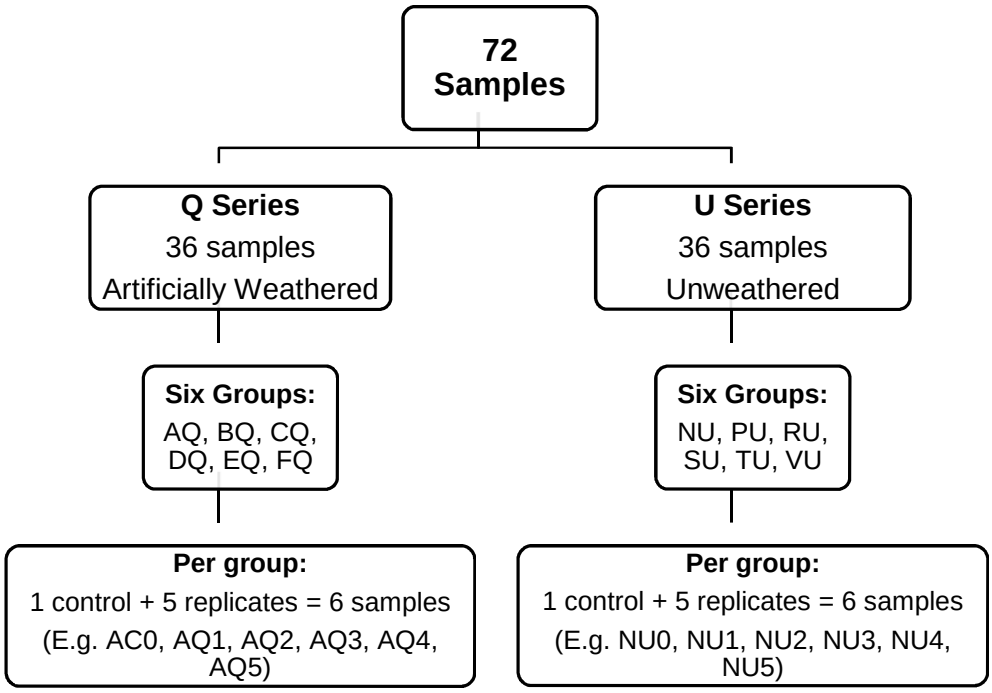

Figure 5.1: Schematic of sample series and groups used for cleaner evaluation

The sample groups were used to evaluate cleaners as shown in Table 5.1. Each cleaner was evaluated using one group from the unweathered (U) sample series and one group from the weathered (Q) sample series. The samples were cleaned using the method described in Chapter 3.

[1] Mineral spirits is a solvent; residual solvent on the sample surface may affect cleaner performance.

	U Series	Q Series
Cleaner	**Group**	**Group**
GoldCrew	NU	AQ
Petro-Clean	PU	BQ
SC-1000	RU	CQ
De-Solv-It APC	SU	DQ
Cytosol	TU	EQ
De-Solv-It Industrial Formula	VU	FQ

Table 5.1: Cleaners and corresponding sample groups

5.1.1 Unweathered (U Series) Samples

Soiled and cleaned U series samples are shown in Figure 5.2 through Figure 5.7; the sample to the left in each group is a control sample. The cleaned samples were evaluated to compare cleaner effectiveness as described below.

Figure 5.2: Unweathered NU samples soiled (top) and cleaned (bottom) with GoldCrew

Figure 5.3: Unweathered PU samples soiled (top) and cleaned (bottom) with Petro-Clean

Figure 5.4: Unweathered RU samples soiled (top) and cleaned (bottom) with SC-1000

Figure 5.5: Unweathered SU samples soiled (top) and cleaned (bottom) with De-Solv-It APC

Figure 5.6: Unweathered TU samples soiled (top) and cleaned (bottom) with Cytosol

Figure 5.7: Unweathered VU samples soiled (top) and cleaned (bottom) with De-Solv-It Industrial Formula

5.1.2 Artificially Weathered Samples

Q series samples after being artificially weathered and after being cleaned are shown in Figure 5.8 through Figure 5.13. The cleaned samples were evaluated to compare cleaner effectiveness as described below; the sample to the left in each group is a control sample.

Figure 5.8: AQ samples soiled and weathered (top), and cleaned (bottom) with GoldCrew

Figure 5.9: BQ samples soiled and weathered (top), and cleaned (bottom) with Petro-Clean

Figure 5.10: CQ samples soiled and weathered (top), and cleaned (bottom) with SC-1000

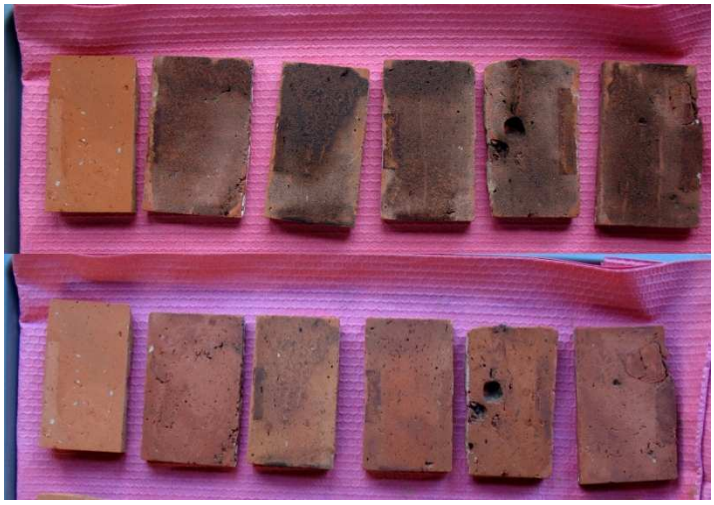

Figure 5.11: DQ samples soiled and weathered (top), and cleaned (bottom) with De-Solv-It APC

Figure 5.12: EQ samples soiled and weathered (top) and cleaned (bottom) with Cytosol

Figure 5.13: FQ samples soiled and weathered (top) and cleaned (bottom) with De-Solv-It Industrial Formula

5.2 Evaluation of Cleaner (SWA) Effectiveness

The effectiveness of each cleaner was evaluated by visual evaluation and telecolorimetry as described below.

5.2.1 Visual Evaluation of SWA Effectiveness by Survey Participants

A group of thirty survey participants visually examined and compared the Q and U series samples cleaned with the six selected cleaners. The samples were divided into twelve groups; each group consisted of one sample per cleaner, for a total of six samples per group (Figure 5.14). Survey participants ranked each sample with a score between 1 and 6 as shown in the survey sheet (Appendix F) based on perceived levels of “least clean” and “most clean” respectively.

Figure 5.14: Bricks grouped for SWA effectiveness evaluation by visual survey participants

Results

Figure 5.15 shows results of the visual survey for unweathered samples cleaned with the selected six SWA. Based on survey results, Cytosol and De-Solv-It Industrial Formula appear to be most effective at removing oil from unweathered samples compared to all other SWA. GoldCrew and Petro-Clean are least effective on unweathered samples. Cytosol is approximately 5 times more effective than GoldCrew and Petro-Clean, and 2.5 times more effective than SC-1000 and De-Solv-It APC.

Figure 5.16 shows results of the visual survey for weathered samples cleaned with the selected SWA. Cytosol and SC-1000 are most effective at removing oil from weathered samples compared to all other SWA. GoldCrew is least effective on weathered samples. Cytosol and SC-1000 are approximately 4 times more effective on weathered samples than GoldCrew, and 2.5 times more effective than Petro-Clean and De-Solv-It Industrial Formula.

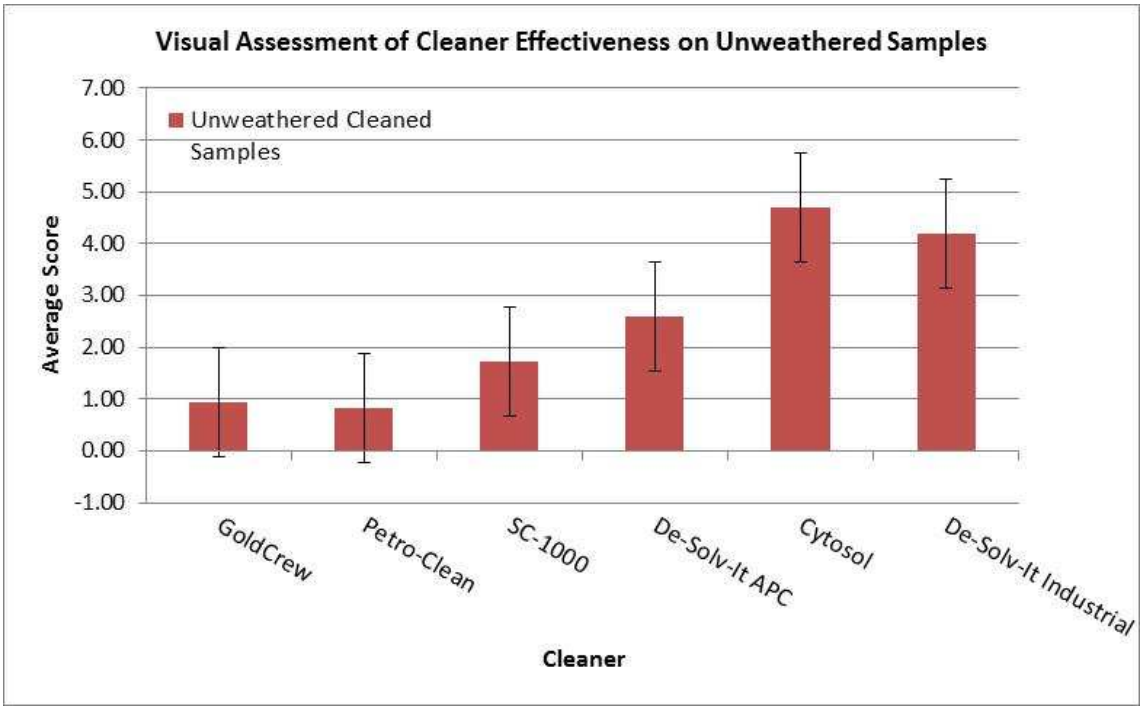

Figure 5.15: Results of visual assessment of cleaner effectiveness on unweathered samples. Note: Higher scores indicate cleaner samples.

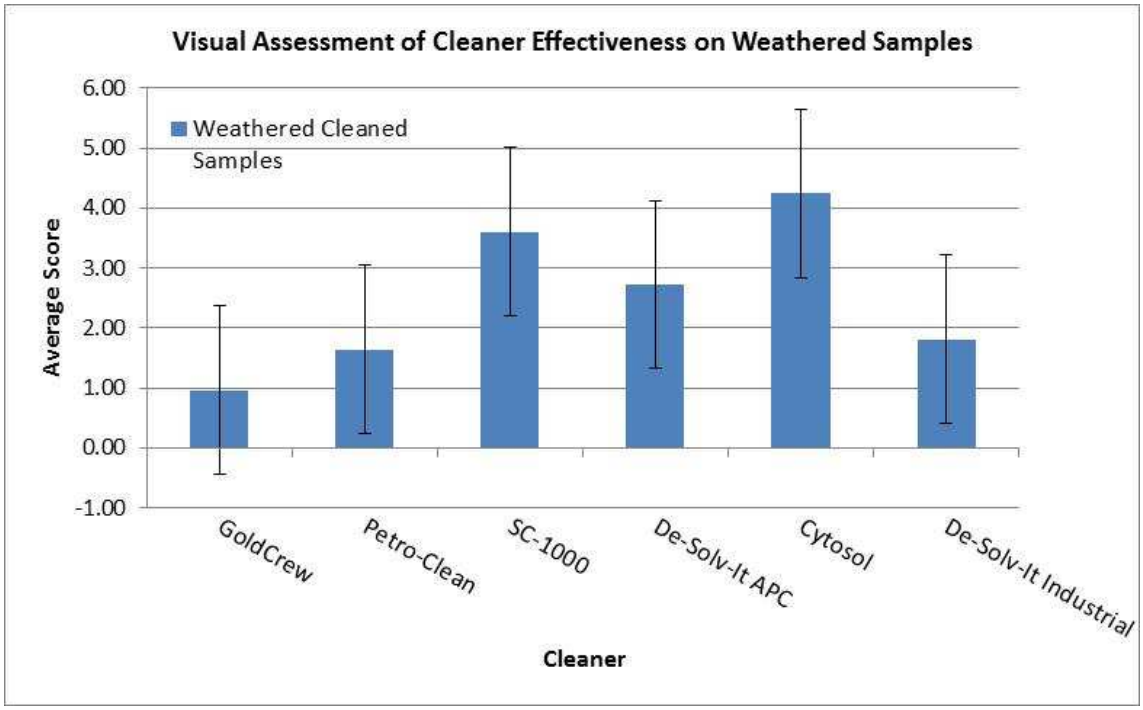

Figure 5.16: Results of visual assessment of cleaner effectiveness on weathered samples. Note: Higher scores indicate cleaner samples.

Figure Figure 5.17 shows a comparison of visual survey results for unweathered and weathered samples cleaned with the selected SWA. Cytosol is the most effective at removing oil from both weathered and unweathered samples. GoldCrew is ineffective on unweathered and weathered samples.

De-Solv-It APC is effective on unweathered and weathered samples; however, it is significantly less effective than Cytosol. Petro-Clean and SC-1000 are more effective on weathered samples than unweathered samples. De-Solv-It Industrial Formula is significantly more effective on unweathered samples than weathered samples.

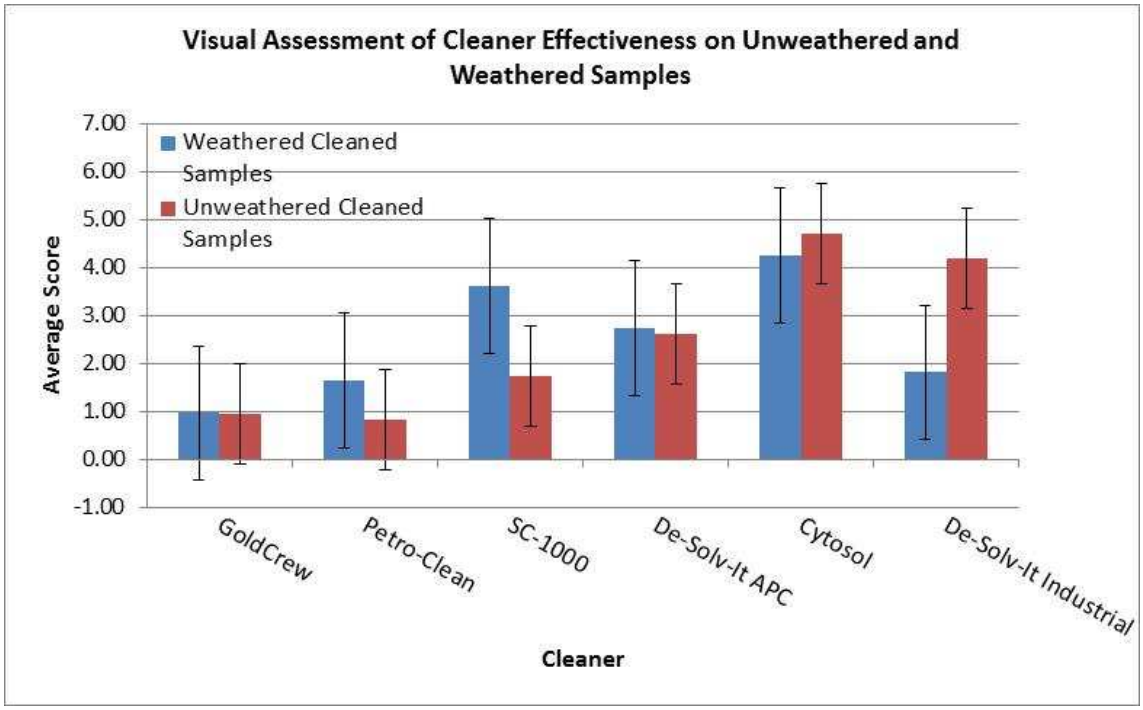

Figure 5.17: Comparison of cleaner effectiveness on unweathered and weathered samples based on results of visual assessment. Note: Higher scores indicate cleaner samples.

Discussion

As noted in previous chapters, laboratory evaluations of SWA effectiveness have previously been conducted on sand and gravel.[2] Oil penetrates sand and gravel differently than masonry surfaces such as brick and stone. Laboratory evaluation of SWA on unweathered or weathered soiled masonry substrates has not been previously conducted. In this study, SWA effectiveness was evaluated on both unweathered and weathered samples for comparison. However, for practical reasons, the results of SWA effectiveness on weathered samples are of primary interest because remediation of soiled masonry generally occurs in the later phases of oil

[2] Koran, Karen Miller, Albert D. Venosa, Christopher C. Leudeker, Keith Dunnigan, and George A. Sorial. "Development and testing of a new protocol for evaluating the effectiveness of oil spill surface washing agents." *Marine Pollution Bulletin* 58 (2009): 1903-1908. Print.

spill response, when the oil has weathered on the masonry substrate. Weathering starts as soon as crude oil is released on the surface of the water, and continues for years.[3]

Factors such as cleaner concentration, dwell-time, and slight variations in cleaning technique may have affected cleaner effectiveness[4]; however, the primary reason for different cleaning results on weathered and unweathered samples is likely the effect of weathering on the composition of crude oil. Crude oil weathering includes physical and chemical processes such as evaporation, photooxidation, emulsification, dispersion, dissolution, biodegradation, sedimentation, and tar ball formation.[5] Physical weathering processes affect the change in composition of crude oil, however processes such as photooxidation and biodegradation most significantly alter the chemical composition of crude oil after a spill.[6]

Volatile components in crude oil evaporate within 24 to 48 hours of exposure to solar radiation; light crude oils such as the Deepwater Horizon MC252 oil spilled in the Gulf, lose between 10% to 50% mass within the initial few days of a spill.[7] Photooxidation degrades low molecular weight long chain polymers in the oil, producing polar compounds that are more soluble in water than the parent compounds. Depending on the extent of weathering, these polar compounds may be removed by aqueous surfactant cleaners.

Depending on cleaner composition, certain cleaners may be more effective on unweathered rather than weathered crude oil, or vice versa. Table 5.2 shows the composition and selected technical data from product literature; MSDS and other available product data for each cleaner are attached in Appendix B. Notes based on limited information obtained from discussions with product manufacturers are also included in Table 5.2; however, product manufacturers are generally unwilling to divulge proprietary formulations.

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[3] Wang, Zhendi, and Scott Stout. *Oil Spill Environmental Forensics: Fingerprinting and Source Identification*, Burlington: Elsevier, 2006: 29. Print.

[4] After the cleaners dwelled on the soiled sample surface, each sample was cleaned manually by agitating the soiled surface using soft nylon-bristled brushes. Slight variations in pressure and agitation time may have contributed to cleaning results.

[5] Fingas, Mervin F.. "Behaviour of Oil in the Environment." *The Basics of Oil Spill Cleanup*. 2nd ed. Boca Raton, Fla.: Lewis Publishers, 2001. 39-45. Print.

[6] Wang, Zhendi, and Scott Stout. *Oil Spill Environmental Forensics: Fingerprinting and Source Identification*, Burlington: Elsevier, 2006: 34-35. Print.

[7] Ibid., 32

SWA	Ingredients	Solubility in Water	pH	Notes[8]
GoldCrew	Proprietary blend of surfactants, molecular detergents.	100%	9.76 ± 0.01	Linear micelle action for oil removal.
Petro-Clean	Mixture of water, emulsifiers, non-ionic surfactants, dispersants, naturally occurring micro-organisms (non-pathogenic).	100%	7.0 - 8.0	N/a
SAFE CARE SC-1000	Non-ionic surfactants and seed ester alcohols.	99.94%	10.2 - 10.5	SC-1000 dissolves oil and displaces oil fractions. Product forms a reversible emulsion with oil.
De-Solv-It Clean-Away APC Super Concentrate	Biodegradable.	100%	9 - 9.5	Water-based product. Food-grade surfactant package, salts, detergents, chelates. Product is essentially soap. Works better on light oils than heavy asphaltic oils. Used on the Exxon-Valdez spill in combination with solvent-based De-Solv-It Industrial Formula.
CytoSol Biosolvent	Proprietary formulation of soy oil methyl esters and bioremediation enhancers.	Negligible (7 ppm in sea water)	Neutral	Biosolvent blend of vegetable oils and animal fats that dissolve other oils. Leaves a film of oil on substrate but will biodegrade after a few weeks.
De-Solv-It Industrial Formula	D-limonene, non-ionic proprietary surfactants and mineral oil (carrier solvent). Biodegradable.	None. Miscible in oil and solvents	6.6	Oil based. D-limonene and mineral oil, small quantity of surfactants.

Table 5.2: Composition and product data of SWA selected for evaluation

Polarity of solvents also affects performance of solvent-based cleaners. Based on information regarding cleaner solubility in water, the first four cleaners appear to be polar and

[8] Notes are based on additional information obtained from product manufacturers. Additional information from the manufacturer was not available for Petro-Clean.

Cytosol Biosolvent and De-Solv-It Industrial Formula appear to be non-polar. As noted above, Cytosol was most effective at removing oil from weathered samples compared to all other SWA evaluated in this study. According to the manufacturer, Cytosol is a two-part cleaner that contains a blend of solvents from animal and vegetable fats, and bioremediation (nutrient) enhancers. Bioremediation enhancers stimulate naturally occurring hydrocarbon-degrading bacteria and increase the rate of hydrocarbon biodegradation.[9] The solvents in Cytosol solubilize the oil on the substrate, making it easier to mobilize and remove from the substrate.

When used on marine oil spills, the mobilized oil and Cytosol solution floats on the water and can be collected with booms or sorbent pads. In a marine environment, residual oil continues to be removed by biodegradation. The nutrient enhancers in Cytosol increase the rate of biodegradation of residual oil by indigenous, naturally occurring, hydrocarbon-degrading bacteria.[10] Continued biodegradation of residual oil requires prolonged contact with indigenous bacteria found in seawater and is not expected to occur in laboratory evaluations.

De-Solv-It Industrial is a d-limonene-based cleaner containing a blend of other solvents that likely dissolved crude oil on the unweathered sample surface, allowing it to be removed during cleaning. As explained above, weathering produces water-soluble compounds that are more easily removed from the sample surface by aqueous surfactant cleaners. Based on this fact, it is not surprising that De-Solv-It Industrial was likely more effective on unweathered samples than weathered samples.

As noted above, De-Solv-It APC, SC-1000, Petro-Clean, and GoldCrew are aqueous surfactant cleaners that are effective for removing weathered oil, which contains water-soluble polar compounds. As shown in Figure 5.17, De-Solv-It APC was effective on both unweathered and weathered samples whereas the other surfactant cleaners were effective on either unweathered or weathered samples. Based on discussions with the manufacturer, this is likely due to the combination of the surfactant package, detergent, and other ingredients in the product. However, as noted in Table 5.2 the product is less effective on heavy or asphaltic oils and may not be as effective on staining from medium or heavy crude oil types.[11]

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[9] Sutiknowati, Lies Indah. "Hydrocarbon Degrading Bacteria: Isolation and Identification." *Makara, Sains* Vol. II, No. 2 (2007): 98-103. Print.

[10] "CytoCulture Environmental Biotechnology Home Page." *CytoCulture Environmental Biotechnology Home Page*. N.p., n.d. Web. <http://www.cytoculture.com/process.html> (Accessed on 3 May 2011).

[11] Based on experience in cleaning oil after the Exxon-Valdez spill, the product manufacturer recommends using the De-Solv-It APC and Industrial Formula in combination to remove crude oil from substrates.

In summary, based on the survey results, Cytosol is the most effective of all SWA evaluated in this study. Aqueous surfactant-based cleaners (Petro-Clean, SC-1000, and De-Solv-It APC) were more effective on weathered samples than on unweathered samples, likely because they can remove weathering products of light crude oil, which are water-soluble. GoldCrew was not effective on unweathered or weathered samples. The organic solvent-based cleaner De-Solv-It Industrial was effective on unweathered samples soiled with crude oil containing organic compounds that can be removed by solvent dissolution.

5.2.2 Telecolorimetry

Colorimetry measurements were made on all samples before and after soaking in water and soiling, after weathering (Q series samples), and after cleaning, as shown in the experimental design (Appendix A). Non-contact colorimetry (telecolorimetry) was used to analyze all samples in this study. A PM-1600F charge-coupled device (CCD) Imaging Photometer and Colorimeter manufactured by Radiant Imaging was used for colorimetry measurements.[12] The colorimeter was set up in accordance with ASTM E811-09 *Standard Practice for Measuring Colorimetric Characteristics of Retroreflectors Under Nighttime Conditions*, which includes telecolorimetry.

The samples were illuminated with a D65 light source that has a correlated color temperature of approximately 6500K, which simulates the full spectrum of daylight. The International Commission on Illumination (CIE) recommends D65 as a light source for all colorimetric calculations that require representative daylight.[13] Figure 5.18 and Figure 5.19 show the typical set-up for colorimetry measurements used in this study; the camera was positioned at an angle of 25 degrees relative to the sample surface.

The telecolorimeter measures luminance (L) and chromaticity (perceived strength of a color) coordinates corresponding to the CIE system. Luminance is a discrete measurement of perceived brightness of a color. Each color has a distinct luminance value relative to black (0%

[12] Colorimetry using a spot colorimeter requires contact with the substrate and was not feasible for this study, because contact of the spot colorimeter with the soiled surface would disturb soiling from the brick samples prior to cleaning.

[13] "ISO 10526:1999/CIE S005-1998." CIE - INTERNATIONAL COMMISSION ON ILLUMINATION. http://www.cie.co.at/publ/abst/s005.html (Accessed on March 9, 2011)

luminance) and white (100% luminance).[14] The 1976 CIE chart was used for colorimetry measurements in this study. Color coordinates L*, a*, and b* are used to calculate Delta E, which indicates the deviation of a color (color shift) from the established CIE chromaticity standard shown in Figure 5.20. Delta E of zero indicates no deviation of measured color from the standard; accordingly higher Delta E values indicate greater deviation from the standard.

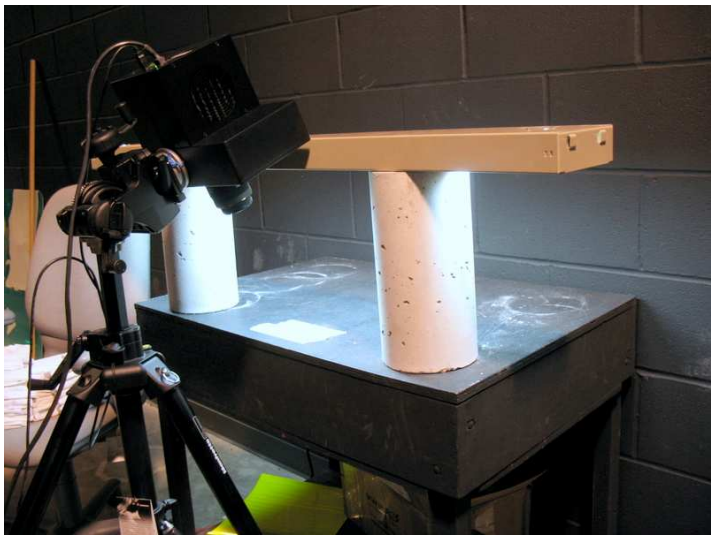

Figure 5.18: CCD telecolorimeter set up in a darkroom

[14] "HyperPhysics." *1976 CIE Chromaticity Diagram*. N.p., n.d. Web. http://hyperphysics.phy-astr.gsu.edu/hbase/hframe.html (Accessed on April 15, 2011)

Figure 5.19: Colorimetry measurements being done on a sample

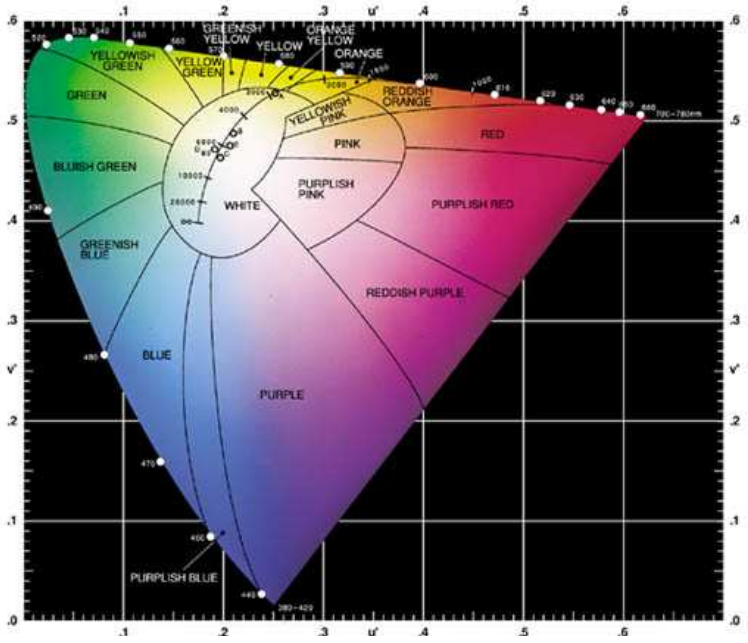

Figure 5.20: 1976 CIE chromaticity diagram[15]

[15] Ibid.

Luminance measurements are typically made at points on a surface; however, in this study luminance measurements were made over the surface area of each brick (approximately 3-1/4 x 2-1/4 inches) in order to measure cleaner effectiveness on the soiled surface area. The telecolorimeter averages luminance data for surface areas greater than 5 mm, which are reported in candela/meter^2 (cd/m^2) rather than percentage.

Change in luminance (Delta L) and Delta E were calculated between conditioned, soaked, soiled, weathered (Q series samples only), and cleaned samples in order to determine cleaner effectiveness. In this study, the cleaner that yields the lowest Delta L and the lowest Delta E between cleaned and conditioned samples would be considered most effective in removing soiling from the sample surface. For cleaners that yield differing trends in Delta L and Delta E, cleaner effectiveness is determined by Delta E values rather than Delta L, because as noted above, Delta E calculations include luminance, which is a discrete measurement. The sample conditions are described below:

Conditioned: Samples after conditioning and weighing in accordance with ASTM C67-09 *Standard Test Methods for Sampling and Testing Brick and Structural Clay Tile*

Soaked: Samples soaked for 24 hours in a 3.4% saline solution to prepare for soiling

Soiled: Samples soiled with crude oil collected from Grand Terre Island, diluted with odorless mineral spirits

Weathered: Q series samples artificially weathered for 720 hours in a Weather-OMeter (WOM), in accordance with ASTM G155-05 *Standard Practice for Operating Xenon Arc Light Apparatus for Exposure of Non-Metallic Materials*

Cleaned: Samples cleaned with selected SWA as described in Chapter 3

Delta L and Delta E values between cleaned and conditioned samples are expected to be lowest compared to those between other conditions, indicating effective removal of soiling to restore the brick surface to pre-soiling conditions. The results of colorimetry measurements as change in luminance (Delta L) and Delta E are discussed below.

5.2.2.1 Telecolorimetry Results for Unweathered (U Series) Samples

Luminance

5.21 shows the difference in luminance between cleaned and conditioned unweathered samples. Samples cleaned with Cytosol and De-Solv-It Industrial Formula have the lowest Delta L, whereas Delta L values of samples cleaned with GoldCrew, Petro-Clean, SC-1000, and De-Solv-It APC are approximately 2 times greater than those of Cytosol and De-Solv-It Industrial Formula. Conditioned samples are samples prior to being soaked, soiled, or cleaned, and in this study, are intended to represent brick before the oil spill. As noted above, samples cleaned with an SWA that most effectively removes oil from the sample surface should have the lowest Delta L values.

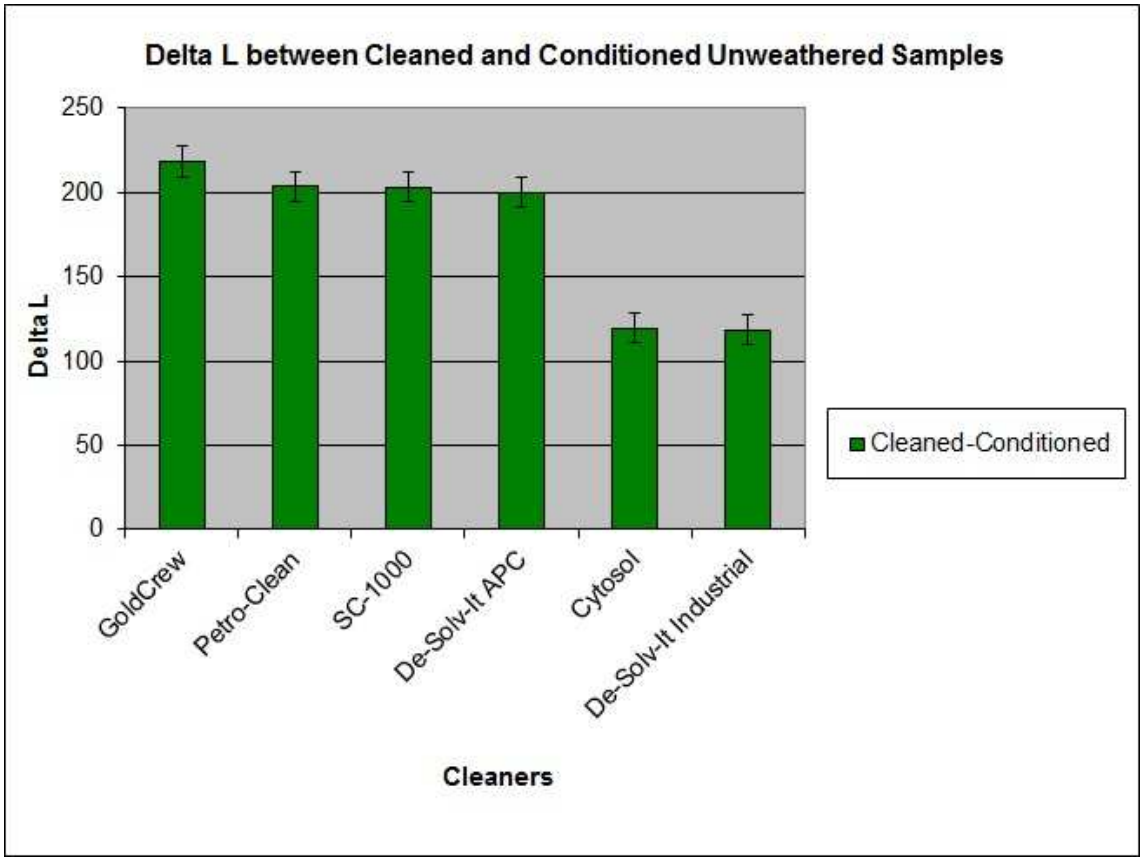

Figure 5.21: Difference in luminance between cleaned and conditioned unweathered (U series) samples. Higher Delta L indicates lower cleaner effectiveness. Note: The error is calculated to one standard deviation.

Based on the above results, Cytosol and De-Solv-It Industrial Formula were able to most effectively restore the luminance of unweathered samples closest to pre-soiling conditions.

Delta E

Figure 5.22 shows the Delta E values between each stage of the study. As noted above, Delta E is the shift in color from the CIE standard. The higher the Delta E value, the greater the shift in color from the standard. Samples soiled with crude oil have the most perceptible color shift compared to the same samples as-conditioned. Therefore, as expected, soaked-soiled Delta E values for all samples are higher compared to other stages of evaluation.

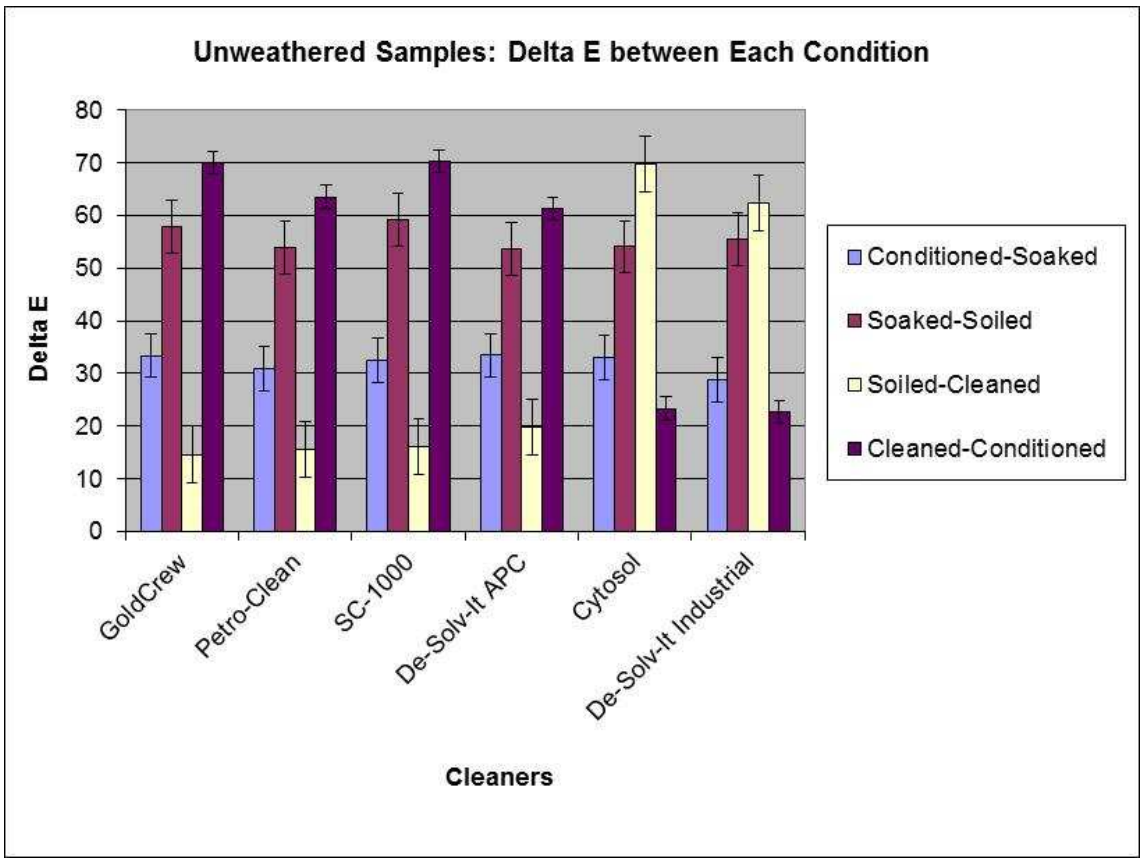

Figure 5.22: Delta E for unweathered (U series) samples between various stages of cleaner evaluation. Note: The error is calculated to one standard deviation.

Figure 5.23 shows cleaned-conditioned Delta E values for each cleaner. Cytosol and De-Solv-It Industrial have the lowest Delta E values compared to all other SWA. Delta E values of unweathered samples cleaned with GoldCrew, Petro-Clean, SC-1000, and De-Solv-It APC are comparable to each other, and are between 2 to 3.5 times greater than those of samples cleaned with Cytosol and De-Solv-It Industrial Formula. This indicates that out of the six SWA evaluated in this study, Cytosol and De-Solv-It Industrial Formula were able to most effectively restore the color of unweathered soiled samples closest to pre-soiling conditions.

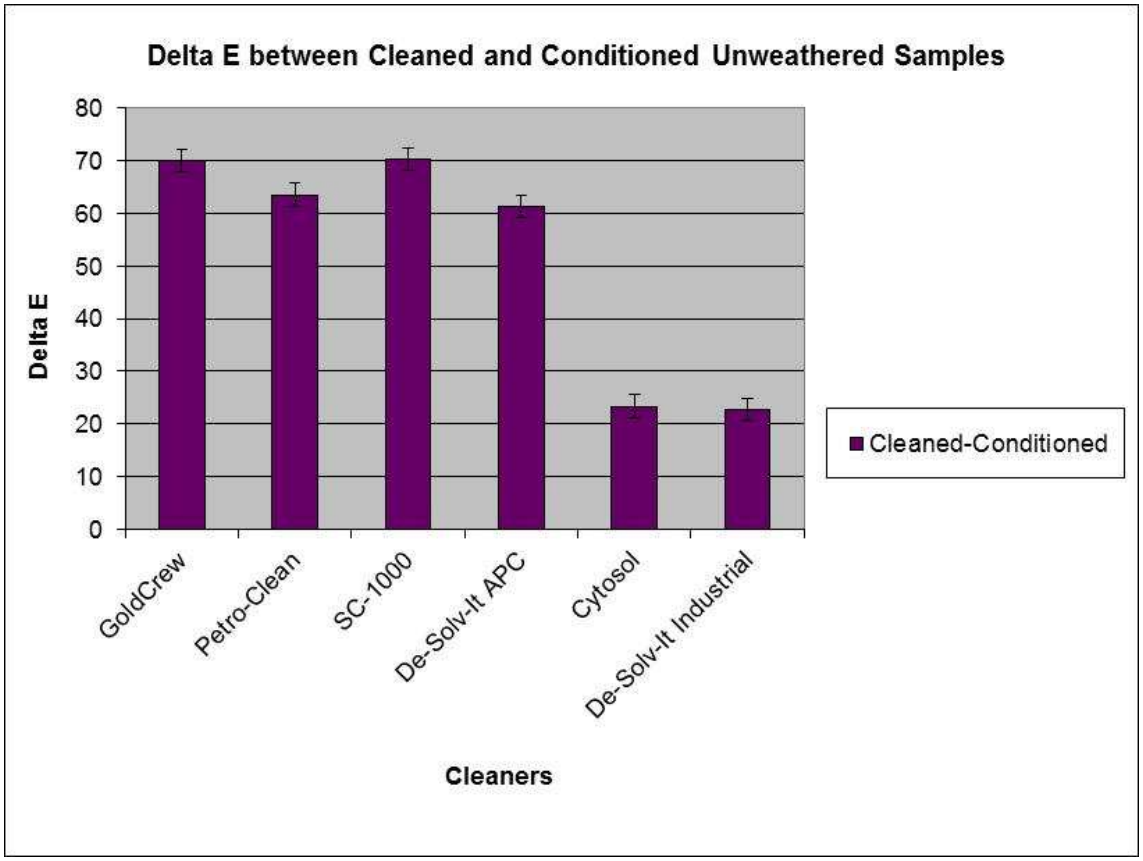

Figure 5.23: Delta E between cleaned and conditioned unweathered (U series) samples. Higher Delta E values denote lower cleaner effectiveness. Note: The error is calculated to one standard deviation.

The above results for Delta L and Delta E correlate to the results of the visual survey for unweathered samples (Figure 5.15), which show that samples cleaned with Cytosol and De-Solv-It Industrial, were perceived as cleanest.

5.2.2.2 Telecolorimetry Results for Weathered (Q Series) Samples

Luminance

Figure 5.24 shows the difference in luminance between cleaned and conditioned weathered samples. Conditioned samples are samples prior to being soaked, soiled, or cleaned, and in this study, are intended to represent brick before the oil spill. As noted above, samples cleaned with an SWA that most effectively removes oil from the sample surface should have the lowest Delta L values. As shown below, samples cleaned with De-Solv-It Industrial Formula have the lowest Delta L values. Delta L values of samples cleaned with Cytosol are highest, and approximately 1.5 times greater than those of De-Solv-It Industrial.

Based on the above results, De-Solv-It Industrial Formula was the only SWA most effectively able to restore the luminance of weathered samples closest to pre-soiling conditions.

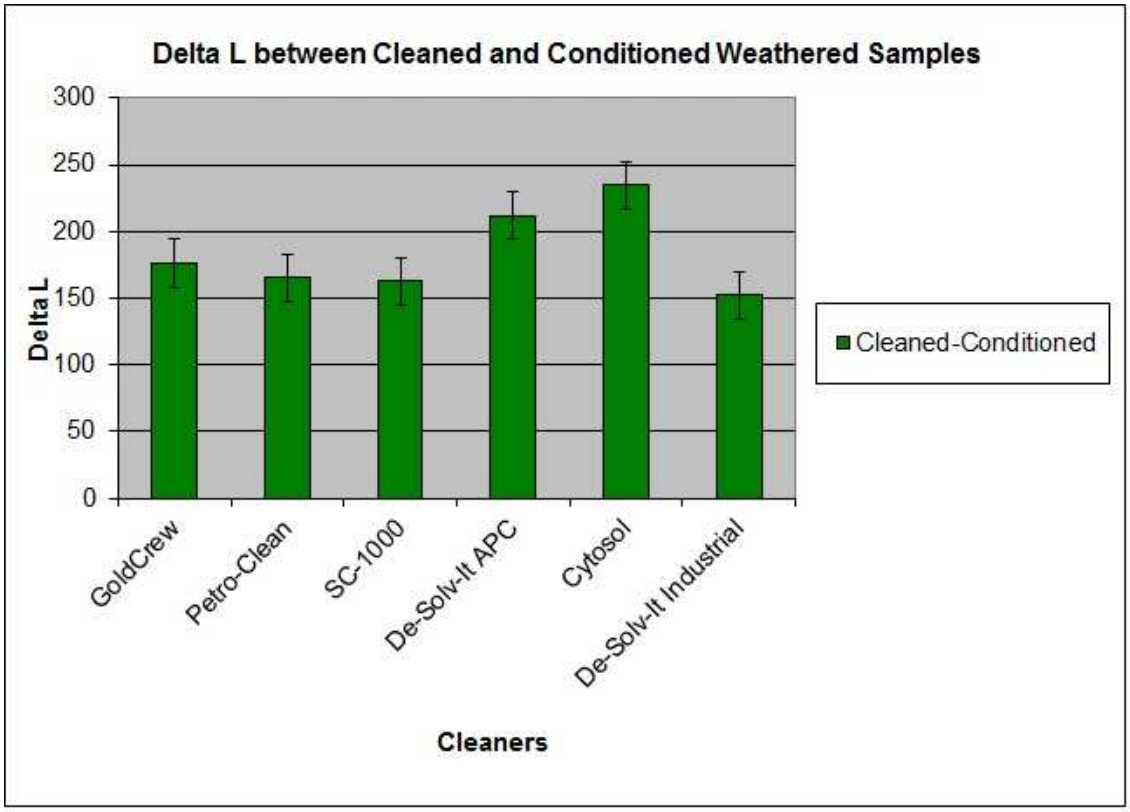

Figure 5.24: Difference in luminance between cleaned and conditioned weathered (Q series) samples. Higher Delta L indicates lower cleaner effectiveness. Note: The error is calculated to one standard deviation.

Delta E

Figure 5.25 shows the Delta E values between each stage of the study. As noted above, Delta E is the shift in color from the CIE standard. Higher Delta E values denote a greater shift in color from the CIE standard. Samples soiled with crude oil have the most perceptible color shift compared to the same samples as-conditioned. Therefore, as expected, soaked-soiled Delta E values for all weathered samples are higher compared to those at other stages of evaluation.

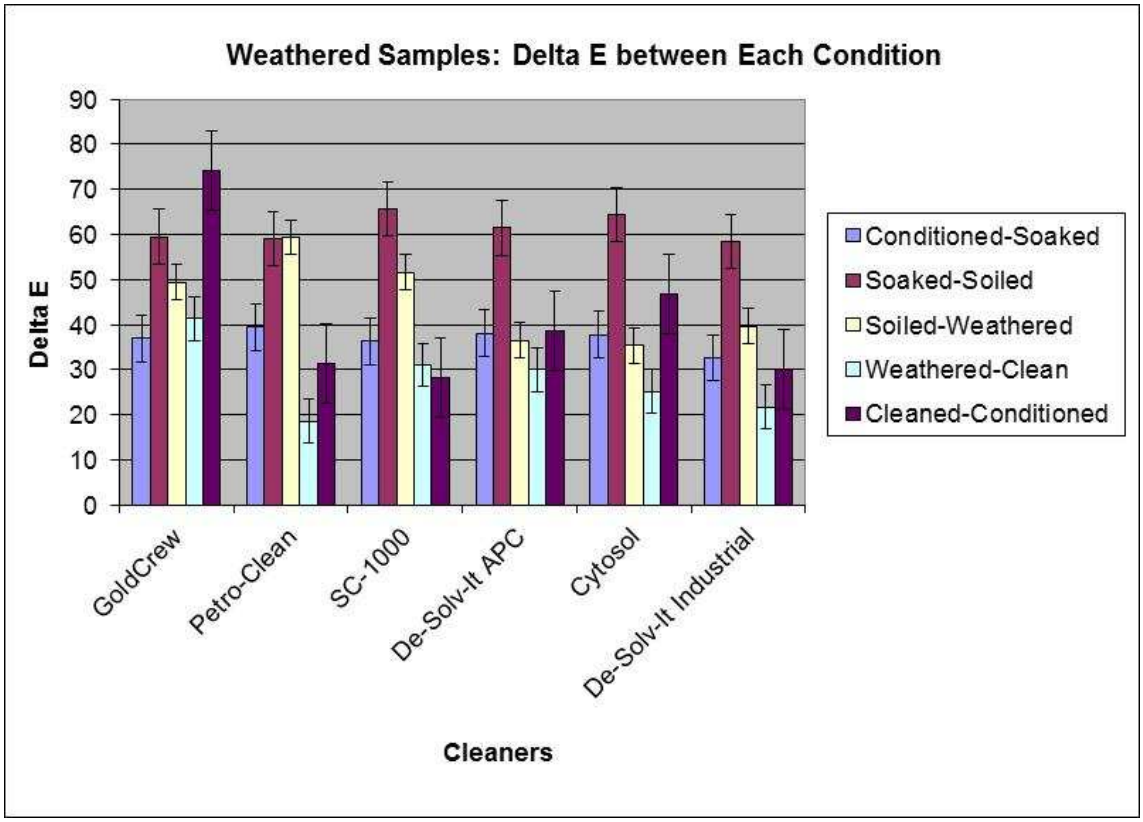

Figure 5.25: Delta E for weathered (Q series) samples between various stages of cleaner evaluation. Note: The error is calculated to one standard deviation.

Figure 5.26 shows cleaned-conditioned Delta E values for each cleaner. Petro-Clean, SC-1000, and De-Solv-It Industrial Formula have the lowest Delta E values compared to all other SWA. The Delta E of weathered samples cleaned with GoldCrew is approximately 2.5 times higher than that of Petro-Clean, SC-1000, and De-Solve-It Industrial Formula, and significantly higher than all other SWA. This indicates that out of the six SWA evaluated in this study, Petro-Clean, SC-1000, and De-Solv-It Industrial Formula were able to most effectively restore the color of weathered soiled samples closest to pre-soiling conditions.

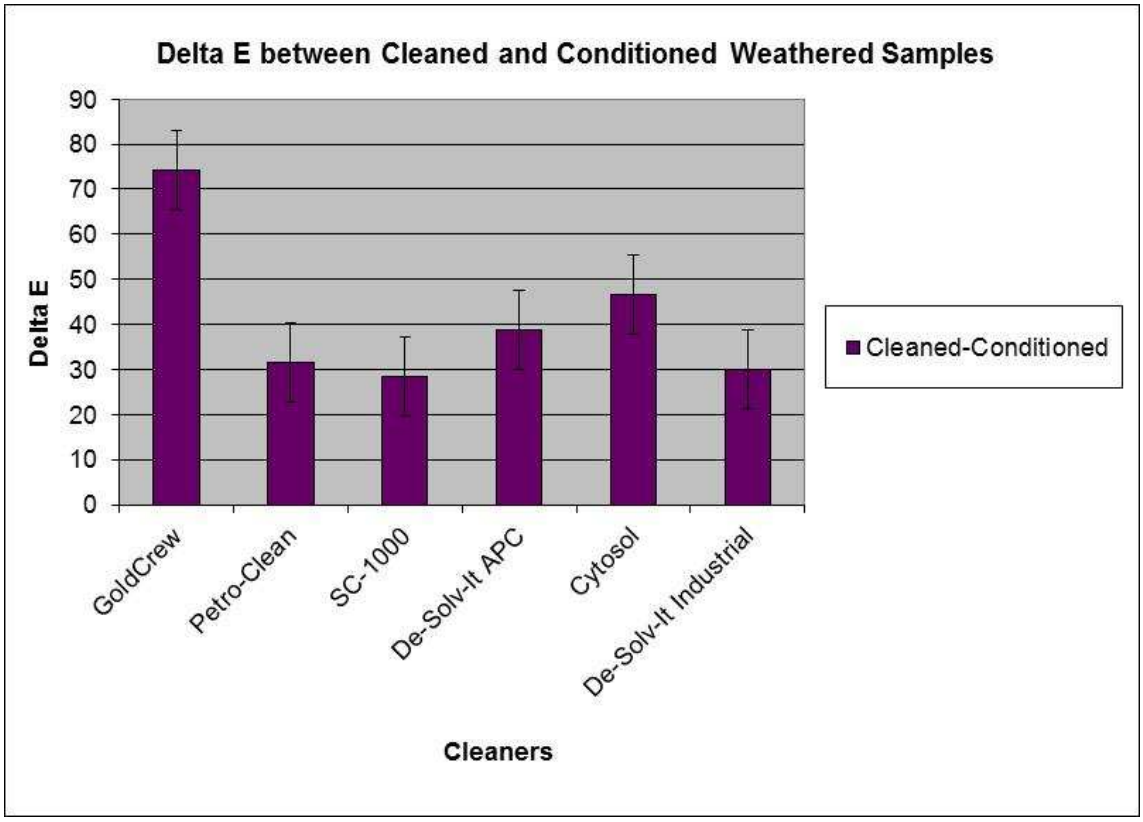

Figure 5.26: Delta E between cleaned and conditioned weathered (Q series) samples. Higher Delta E values denote lower cleaner effectiveness. Note: The error is calculated to one standard deviation.

The above results for Delta L and Delta E have differing trends. As previously noted in this Chapter, when Delta L and Delta E have differing trends, cleaner effectiveness is determined by Delta E values. Based on Delta E results, Petro-Clena, SC-1000, and De-Solv-It Industrial are the most effective cleaners for weathered samples. These results do not correlate to the results of the visual survey for weathered samples (Figure 5.16), which show that SC-1000 and Cytosol were most effective on weathered samples, and Petro-Clean was ineffective.

This lack of correlation is likely due to the fact that Delta E values include luminance values. The telecolorimeter measures average luminance of the entire sample surface including patches of bright and dark areas on the same sample. Therefore, a cleaned sample with patches of bright and dark areas might have a higher average luminance than an evenly cleaned, less bright sample. According to Figure 5.26, Petro-Clean, SC-1000, and De-Solv-It Industrial Formula have

lower Delta E values indicating more effective cleaning, whereas Cytosol and De-Solv-It APC have higher Delta E values, indicating less effective cleaning.

However, as shown in Figure 5.27 weathered samples cleaned with Petro-Clean and De-Solv-It Industrial Formula have patches of bright and dark areas indicating non-uniform cleaning, whereas samples cleaned with SC-1000 are not patchy. As shown in Figure 5.28, samples cleaned with De-Solv-It APC and Cytosol are less bright but are evenly colored, indicating uniform cleaning. Figure 5.29 shows examples of varying degrees of surface uniformity of cleaned samples as observed through the telecolorimeter; each sample was cleaned with a different cleaner.

Figure 5.27: Weathered samples cleaned with Petro-Clean (top), De-Solv-It Industrial Formula (middle), and SC-1000 (bottom)

Figure 5.28: Samples cleaned with De-Solv-It APC (top) and Cytosol (bottom)

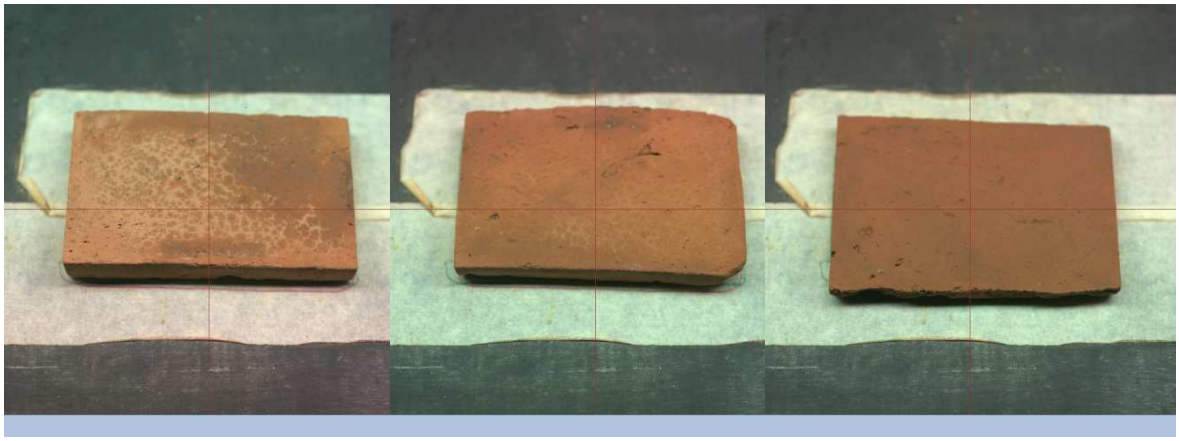

Figure 5.29: Samples with varying degrees of cleaning uniformity as seen through the colorimeter. Note: each sample was cleaned with a different cleaner.

Due to variability in the surface appearance, cleaner effectiveness for weathered samples cannot be determined solely based on colorimetry data. Instead, the visual ranking of the cleaner effectiveness should be more heavily relied upon.

Chapter 6: Conclusions and Recommendations

The objective of this study was to address the following question pertaining to stained masonry materials:

What are the factors that affect the selection of remedial treatments for the complex staining of masonry materials on cultural resources located in environmentally sensitive sites such as Fort Livingston, Louisiana on the Gulf Coast of the United States and other locations, which are impacted by pollutants including crude oil?

In general, factors that affect the selection of remedial treatments are site location, type of soiling, and type of substrate. Fort Livingston is a brick-and-tabby structure located on Grand Terre Island in the Gulf of Mexico. After the Deepwater Horizon oil spill in April 2010 the Fort, which is partially submerged under water during high tide, was soiled by crude oil. Location-based factors that affect the selection of remedial treatments at Fort Livingston include limited access to the site, strict regulations for disposal of effluent and other waste, lack of fresh water, electricity, and on-site waste disposal, and weather-related constraints such as tides and storms.

Additionally, limited research has been conducted into cleaners effective for removal of crude oil from masonry. Laboratory evaluation is helpful in identifying cleaners suitable for field trials in remote locations; however, standard procedures have not been developed for laboratory evaluation of cleaners for the removal of crude oil from masonry. As noted in Chapter 2, as a part of the National Contingency Plan (NCP), the EPA publishes a Product Schedule containing a list of products that may be used for the remediation of oil and hazardous substance spill response. The products are categorized as follows:

- Bioremediation Agents
- Dispersants
- Surface Washing Agents (SWA)
- Miscellaneous Oil Spill Control Agents (MOSCA)

SWA are recommended for removal of oil from solid surfaces such as masonry, after which the effluent is collected for disposal. Prior to listing an SWA on the Product Schedule, the EPA requires manufacturers to submit results of various tests including toxicity tests; however, effectiveness testing of SWA is not required. On-site testing is useful for selecting products best suited for remediation of a particular site. Since on-site testing was not possible due to limited access to the Fort, an experimental design was developed to evaluate promising cleaners in the laboratory prior to on-site testing. Based on the above factors, cleaners selected for laboratory evaluation were generally limited to products that:

- do not require long dwell times
- are easy to transport to the site
- can be applied with portable equipment
- produce effluent that can be collected for off-site disposal
- are listed on the NCP Product Schedule

Research was conducted collaboratively at NCPTT and UT-Austin to identify a series of suitable SWA and to develop methods for evaluating SWA effectiveness in the laboratory. The specific focus of the research was as follows:

1. Prepare samples in the laboratory to represent site conditions at Fort Livingston, for use in evaluating SWA effectiveness
2. Develop consistent and reproducible methods of conditioning, soiling, weathering, and cleaning samples in the laboratory
3. Evaluate selected SWA for effectiveness in removing weathered crude oil from the prepared samples

6.1 Conclusions

Conclusions including results for the most effective SWA based on laboratory evaluations are presented below.

Factors Affecting Cleaner Selection

- Laboratory evaluation shows that the primary factor affecting cleaner selection for remediation of brick masonry stained by light crude oil is the extent of weathering of oil on the masonry. Due to differences in the composition of unweathered and weathered crude oil, cleaners effective for removing weathered oil from brick may have a different effect on unweathered oil, as shown below.

Cleaner Effectiveness

- Based on laboratory evaluation and visual assessment, the most effective cleaners for removing weathered crude oil from brick are listed below in order of decreasing effectiveness:

1. Cytosol
2. SC-1000
3. De-Solv-It APC
4. De-Solv-It Industrial Formula
5. Petro-Clean
6. GoldCrew

- Based on laboratory evaluation and visual assessment, the most effective cleaners for removing unweathered crude oil from brick are listed below in order of effectiveness:

1. Cytosol
2. De-Solv-It Industrial Formula
3. De-Solv-It APC
4. SC-1000
5. GoldCrew
6. Petro-Clean

Experimental Design, Sample Preparation, and Cleaning

- The experimental design was successful in providing a preliminary understanding of SWA performance and effectiveness in the laboratory. The inclusion of telecolorimetry measurements at each step of the study was helpful in providing an understanding of the effect of each stage of sample preparation on the appearance of brick samples.
- The methods developed for sample conditioning, soiling, and weathering were consistent and reproducible in the laboratory.
- The method developed for cleaning soiled and weathered samples was also consistent and reproducible in the laboratory.

Evaluation of Cleaned Samples

Although useful, laboratory evaluation is not a substitute for on-site evaluation due to limitations such as those discussed below.

- Non-contact analytical methods are required for evaluating samples at each stage of SWA evaluation in order to avoid disturbing the surface soiling on samples. However, limited methods are available for non-contact and non-destructive evaluation of samples, and in this study were limited to visual evaluation and telecolorimetry.
- Visual evaluation was successful in providing reliable preliminary results for weathered and unweathered samples. The results of the visual evaluation of weathered samples were used to determine cleaners suitable for initial field trials described in section 6.3 below.
- Telecolorimetry measurements averaged over the entire surface area of samples may not be a reliable method of evaluating cleaner effectiveness without visual evaluation. Telecolorimeter measurements averaged over the sample surface do not account for non-uniform (patchy) cleaning of samples, and may be misleading.
- Non-destructive techniques such as gas chromatography-mass spectrometry (GC-MS) were not feasible during this project due to time and budget constraints.

6.2 Recommendations for Additional Research

Based on review of existing literature and the results of the laboratory evaluation conducted during this study, our recommendations for further research and testing in the laboratory are discussed below.

Cleaner Types

The recommendations below focus on SWA, which is the product category listed in the NCP Product Schedule that is most relevant to removing oil from solid surfaces. Experimental designs for laboratory evaluation of other types of products such as enzymatic cleaners may be developed, but are not discussed here; the recommendations discussed below focus on SWA.

- Evaluation of SWA in combination:
    a. solvent-based cleaner to solubilize and remove surface soiling and unweathered oil, followed by
    b. surfactant-based cleaner to remove water soluble weathering products
- Laboratory evaluation of SWA containing microorganisms or nutrient enhancers that increase the rate of biodegradation of indigenous microorganisms to examine the effectiveness of microorganisms on weathered and unweathered soiled samples.

  The rate of biodegradation of crude oils depends on ambient temperature, availability of oxygen and nutrients such as nitrogen and phosphorus, and the type of oil. Crude oil from a specific source is most effectively degraded by indigenous microorganisms rather than microorganisms introduced through SWA. Additionally, crude oils and their weathering products contain high molecular weight compounds such as asphaltenes that biodegrade very slowly, or that can be toxic to microorganisms.[1]
- Clean soiled samples using cleaners diluted in varying ratios. EPA guidelines in the NCP Product Schedule recommend the lowest in a range of dilution ratios provided by product manufacturers, even though manufacturers may recommend using cleaners neat for heavily contaminated areas (e.g. SC-1000).

Cleaning Methods and Evaluation

- Evaluate different cleaners by examining control, soiled, weathered, and cleaned brick under UV light (hydrocarbons fluoresce at specific wavelengths) to compare the quantity of oil at each step of the experiment.
- Artificially weather cleaned brick to determine any adverse effects of cleaners by comparing cleaned brick and cleaned, weathered brick.

[1] Ibid. 49-50.

- Adverse effects can be evaluated using non-contact analytical methods such as telecolorimetry and visual evaluation, followed by scanning electron microscope (SEM) analysis of sample cross-sections.
- Conduct SEM analysis to understand depth of penetration of oil and cleaner action and effectiveness on:
    a. weathered and unweathered soiled brick
    b. weathered and unweathered soiled, cleaned brick
- Products evaluated in this study for use at Fort Livingston were limited to those with a dwell time of less than 2 hours due to the remote location and variable weather on Grand Terre Island. However, experimental designs may be developed for laboratory evaluation of cleaners in poultice form with varying dwell times.

Evaluation of Other Crude Oils

- The oil spilled in the Gulf was a light crude oil. The composition and weathering products of medium and heavy oils are different from those of light crude oil.[2] Cleaning experiments on samples soiled with heavy and medium oils using the above described approaches may help identify cleaners for future spills of other crude oil types.

6.3 Cleaners Recommended for Field Trials at Fort Livingston

The cleaners listed below are recommended for field trials at Fort Livingston, in order of performance. During initial field trials, each cleaner should be applied using methods recommended by the manufacturer; application methods may be modified based on additional laboratory evaluation or results of initial field trials. The following cleaner recommendations are based on results of cleaner effectiveness on weathered samples, because remediation of contaminated sites usually occurs in later phases of oil spill response, after the oil has started to weather on the masonry.[3] Recommendations for cleaner combinations are based on results of cleaning evaluations on weathered and unweathered samples, and as discussed in Chapter 5, an understanding of the effect of weathering on crude oil.

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[2] Wang, Zhendi, and Scott Stout. *Oil Spill Environmental Forensics: Fingerprinting and Source Identification*, Burlington: Elsevier, 2006: 29-35. Print.

[3] Fingas, Mervin F.. "Shoreline Cleanup and Restoration." *The Basics of Oil Spill Cleanup*. 2nd ed. Boca Raton, Fla.: Lewis Publishers, 2001. 39-40. Print.

1. Cytosol
2. SC-1000
3. De-Solv-It APC
4. De-Solv-It Industrial followed by De-Solv-It APC
5. De-Solv-It Industrial followed by SC-1000

This study indicates that timing is a critical factor affecting the selection of remedial treatments for masonry on remotely located cultural resources. The composition of crude oil on masonry changes over time and cleaner selection depends on the extent of weathering that has occurred. SWA that effectively remove the water-soluble products of weathered crude oil are different from SWA that effectively remove unweathered crude oil from masonry surfaces.

For light crude oils, organic solvent-based cleaners may be most effective if cleaning is possible soon after the staining occurs. However, remediation of stained surfaces such as structures and shorelines generally occurs in later phases of oil spill response, when the oil has weathered on the surface for some extent of time. Aqueous surfactant cleaners are most effective for removing weathered light crude oil from masonry.

Appendix A: Experimental Design

Surface Washing Agent (SWA) Study Sample Matrix - Weathered Samples

						0-720 hours WOM and after						
Sample ID#	WT	CO/ Photo	ST	SL	WT	WOM	CO/ Photo	WT	CL	WT	CO/ Photo	VIS
AC0	YES	YES	YES	NO	YES	NO	YES	YES	NO	NO	NO	YES
AQ1	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
AQ2	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
AQ3	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
AQ4	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
AQ5	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
BC0	YES	YES	YES	NO	YES	NO	YES	YES	NO	NO	NO	YES
BQ1	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
BQ2	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
BQ3	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
BQ4	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
BQ5	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
CC0	YES	YES	YES	NO	YES	NO	YES	YES	NO	NO	NO	YES
CQ1	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
CQ2	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
CQ3	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
CQ4	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
CQ5	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
DC0	YES	YES	YES	NO	YES	NO	YES	YES	NO	NO	NO	YES
DQ1	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
DQ2	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
DQ3	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
DQ4	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
DQ5	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
EC0	YES	YES	YES	NO	YES	NO	YES	YES	NO	NO	NO	YES
EQ1	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
EQ2	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
EQ3	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
EQ4	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
EQ5	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
FC0	YES	YES	YES	NO	YES	NO	YES	YES	NO	NO	NO	YES
FQ1	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
FQ2	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
FQ3	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
FQ4	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
FQ5	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES

Sample Nomenclature:

First Letter represents SWA used

Second letter represents Control (C), artifically weathered in QUV or WOM (Q), unweathered (U)

Third digit is the sample/replicate number

E.g.

NU1 = SW-23 Petro-Clean Unweathered Sample #1

Notes

WT= Weight by mass

CO= Colorimetry

ST= Saturate in salt water for 48 hours[1]

SL= Soil with oil collected from Ft. Livingston[2]

QUV= Artificial Weathering

CL= Clean

VIS= Visual Evaluation by Survey Participants

Absorption Data - Weathered Samples

	Absorption Test		
Sample ID#	WT1 (g)	WT2 (g)	% absorption
AC0	105.12	121.16	15.26
AQ1	113.81	133.66	17.44
AQ2	100.78	117.50	16.59
AQ3	103.78	122.16	17.71
AQ4	99.04	116.05	17.17
AQ5	118.16	138.37	17.10
BC0	106.95	124.07	16.01
BQ1	137.50	160.12	16.45
BQ2	101.85	119.01	16.85
BQ3	94.38	112.70	19.41
BQ4	106.53	123.80	16.21
BQ5	121.08	142.05	17.32
CC0	119.29	139.64	17.06
CQ1	93.48	109.73	17.38
CQ2	104.94	122.76	16.98
CQ3	110.80	127.47	15.05
CQ4	96.84	114.30	18.03
CQ5	101.05	118.51	17.28
DC0	107.87	125.96	16.77
DQ1	102.02	119.98	17.60
DQ2	106.44	124.73	17.18
DQ3	96.52	113.54	17.63
DQ4	91.85	109.65	19.38
DQ5	111.91	130.84	16.92
EC0	90.40	105.76	16.99
EQ1	90.40	106.32	17.61
EQ2	91.25	107.27	17.56
EQ3	105.26	123.26	17.10
EQ4	111.64	131.88	18.13
EQ5	104.30	121.26	16.26
FC0	107.60	125.98	17.08
FQ1	97.68	113.95	16.66
FQ2	141.91	165.73	16.79
FQ3	98.02	114.38	16.69
FQ4	97.85	116.22	18.77
FQ5	101.05	119.16	17.92

Surface Washing Agent (SWA) Study Sample Matrix - Unweathered Samples

Sample ID#	WT	CO/ Photo	ST	SL	WT	QUV	CO/ Photo	WT	CL	WT	CO/ Photo	VIS
NC0	YES	YES	YES	NO	YES	NO	YES	NO	YES	YES	YES	YES
NU1	YES	YES	YES	YES	YES	NO	YES	NO	YES	YES	YES	YES
NU2	YES	YES	YES	YES	YES	NO	YES	NO	YES	YES	YES	YES
NU3	YES	YES	YES	YES	YES	NO	YES	NO	YES	YES	YES	YES
NU4	YES	YES	YES	YES	YES	NO	YES	NO	YES	YES	YES	YES
NU5	YES	YES	YES	YES	YES	NO	YES	NO	YES	YES	YES	YES
PC0	YES	YES	YES	NO	YES	NO	YES	NO	YES	YES	YES	YES
PU1	YES	YES	YES	YES	YES	NO	YES	NO	YES	YES	YES	YES
PU2	YES	YES	YES	YES	YES	NO	YES	NO	YES	YES	YES	YES
PU3	YES	YES	YES	YES	YES	NO	YES	NO	YES	YES	YES	YES
PU4	YES	YES	YES	YES	YES	NO	YES	NO	YES	YES	YES	YES
PU5	YES	YES	YES	YES	YES	NO	YES	NO	YES	YES	YES	YES
RC0	YES	YES	YES	NO	YES	NO	YES	NO	YES	YES	YES	YES
RU1	YES	YES	YES	YES	YES	NO	YES	NO	YES	YES	YES	YES
RU2	YES	YES	YES	YES	YES	NO	YES	NO	YES	YES	YES	YES
RU3	YES	YES	YES	YES	YES	NO	YES	NO	YES	YES	YES	YES
RU4	YES	YES	YES	YES	YES	NO	YES	NO	YES	YES	YES	YES
RU5	YES	YES	YES	YES	YES	NO	YES	NO	YES	YES	YES	YES
SC0	YES	YES	YES	NO	YES	NO	YES	NO	YES	YES	YES	YES
SU1	YES	YES	YES	YES	YES	NO	YES	NO	YES	YES	YES	YES
SU2	YES	YES	YES	YES	YES	NO	YES	NO	YES	YES	YES	YES
SU3	YES	YES	YES	YES	YES	NO	YES	NO	YES	YES	YES	YES
SU4	YES	YES	YES	YES	YES	NO	YES	NO	YES	YES	YES	YES
SU5	YES	YES	YES	YES	YES	NO	YES	NO	YES	YES	YES	YES
TC0	YES	YES	YES	NO	YES	NO	YES	NO	YES	YES	YES	YES
TU1	YES	YES	YES	YES	YES	NO	YES	NO	YES	YES	YES	YES
TU2	YES	YES	YES	YES	YES	NO	YES	NO	YES	YES	YES	YES
TU3	YES	YES	YES	YES	YES	NO	YES	NO	YES	YES	YES	YES
TU4	YES	YES	YES	YES	YES	NO	YES	NO	YES	YES	YES	YES
TU5	YES	YES	YES	YES	YES	NO	YES	NO	YES	YES	YES	YES
VC0	YES	YES	YES	NO	YES	NO	YES	NO	YES	YES	YES	YES
VU1	YES	YES	YES	YES	YES	NO	YES	NO	YES	YES	YES	YES
VU2	YES	YES	YES	YES	YES	NO	YES	NO	YES	YES	YES	YES
VU3	YES	YES	YES	YES	YES	NO	YES	NO	YES	YES	YES	YES
VU4	YES	YES	YES	YES	YES	NO	YES	NO	YES	YES	YES	YES
VU5	YES	YES	YES	YES	YES	NO	YES	NO	YES	YES	YES	YES

Sample Nomenclature:

First Letter represents SWA used

Second letter represents Control (C), artifically weathered in QUV or WOM (Q), unweathered (U)

Third digit is the sample/replicate number

E.g.

NU1 = SW-23 Petro-Clean Unweathered Sample #1

Notes

WT= Weight by mass

CO= Colorimetry

ST= Saturate in salt water for 48 hours[1]

SL= Soil with oil collected from Ft. Livingston[2]

QUV= Artificial Weathering

CL= Clean

VIS= Visual Evaluation by Survey Participants

Absorption Data - Unweathered Samples

	Absorption Test		
Sample ID#	WT1 (g)	WT2 (g)	% absorption
NC0	96.64	111.79	15.68
NU1	98.24	115.82	17.89
NU2	111.59	130.16	16.64
NU3	102.60	120.08	17.04
NU4	114.47	134.02	17.08
NU5	85.03	101.23	19.05
PC0	119.10	139.61	17.22
PU1	111.00	128.21	15.50
PU2	101.61	118.41	16.53
PU3	89.42	106.06	18.61
PU4	107.41	125.56	16.90
PU5	90.72	108.47	19.57
RC0	103.67	121.36	17.06
RU1	93.97	111.23	18.37
RU2	87.77	102.02	16.24
RU3	101.16	119.47	18.10
RU4	112.15	130.18	16.08
RU5	101.24	115.76	14.34
SC0	91.22	106.80	17.08
SU1	95.08	108.87	14.50
SU2	136.21	156.25	14.71
SU3	108.52	124.63	14.85
SU4	112.32	131.01	16.64
SU5	110.37	129.26	17.12
TC0	103.71	120.22	15.92
TU1	105.65	123.61	17.00
TU2	110.17	128.49	16.63
TU3	92.15	105.35	14.32
TU4	92.89	111.55	20.09
TU5	106.47	124.16	16.62
VC0	99.94	118.15	18.22
VU1	120.49	140.77	16.83
VU2	91.25	109.10	19.56
VU3	103.94	121.33	16.73
VU4	100.16	118.15	17.96
VU5	109.13	126.48	15.90

Appendix B: Product Data – NCP Product Schedule

http://www.epa.gov/ceppo/web/content/ncp/products/biosolve.htm
Last updated on 01/27/2011

Emergency Management

You are here: EPA Home Emergency Management NCP Subpart J NCP Product Schedule
BIOSOLVE® HYDROCARBON MITIGATION™ AGENT

BIOSOLVE® HYDROCARBON MITIGATION™ AGENT

TECHNICAL PRODUCT BULLETIN #SW-20
USEPA, OIL PROGRAM CENTER
ORIGINAL LISTING DATE: MARCH 21, 1997
"BIOSOLVE® HYDROCARBON MITIGATION™ AGENT"

I. NAME, BRAND, OR TRADEMARK

BIOSOLVE® HYDROCARBON MITIGATION™ AGENT
Type of Product: Surface Washing Agent

II. NAME, ADDRESS, AND TELEPHONE NUMBER OF MANUFACTURER

The BioSolve® Company
329 Massachusetts Avenue
Lexington, MA 02420
Phone: (781) 482-7900 or (800) 225-3909
Fax: (781) 482-7909
Web site: http://www.biosolve.com
E-mail: info@biosolve.com
(Mr. Karl Loos or Mr. James Edgerly)

III. NAME, ADDRESS, AND TELEPHONE NUMBER OF PRIMARY DISTRIBUTORS

The BioSolve® Company
329 Massachusetts Avenue
Lexington, MA 02420
Phone: (781) 482-7900 or (800) 225-3909
Fax: (781) 482-7909
Web site: http://www.biosolve.com
E-mail: info@biosolve.com
(Mr. Karl Loos or Mr. James Edgerly)

IV. SPECIAL HANDLING AND WORKER PRECAUTIONS FOR STORAGE AND FIELD APPLICATION

1. Flammability:
Non-flammable
2. Ventilation:
Normal
3. Skin and eye contact; protective clothing; treatment in case of contact:
Flush contaminated eyes thoroughly with water for 15 minutes, and get medical attention. Remove contaminated clothing, wash exposed area with soap and water, wash clothing before reuse. Get medical attention if irritation develops. Get medical attention for

ingestion. No medical attention is necessary with inhalation. There are no special storage requirements or special handling precautions; use good normal hygiene.
4.a. Maximum storage temperature: 120°F (50°C)
4.b. Minimum storage temperature: 35°F (1.5°C)
4.c. Optimum storage temperature: 60°F (15°C)
4.d. Temperatures of phase separations and chemical changes: Not applicable.

V. SHELF LIFE

BIOSOLVE® has a 10+ year shelf life if unopened.

VI. RECOMMENDED APPLICATION PROCEDURE

1. Application Method:
Dilute or use eductors to specified rate and apply through fire hose, power washers, steam powered units, or chemical boom sprayers with nozzles that produce a shearing action. Special nozzles to apply the solution as droplets are not necessary. For shoreline cleanup involving heavy or weathered crude, presoak to a 6% solution may be necessary.
2. Concentration/Application Rate:

BIOSOLVE® is a highly concentrated product and must be diluted with water before use. Dilution ratios vary depending on site specific conditions. Dilution ratio's normally run at 6%, 3%, or 1%. For heavy, mousse, or weathered oil, a 3% to 6% solution should be applied. For light or refined products, apply at 2% to 3%. For sheens, apply at .5 to 1%.

Since testing shows that BIOSOLVE® quickly emulsifies weathered crude, it is not critical to apply immediately after a spill occurs; impact considerations can be fully considered prior to action taken.

Surface Washing Applications: BIOSOLVE® applied through power washers in light dilution is very effective in attaining the removal of oils from rock, cobblestone, shorelines, and sea walls. In marsh or wetland applications, BIOSOLVE® prevents the oil from clinging to grasses and mangroves.

Rigs and Platforms: BIOSOLVE® is used to inert undersea pipelines before plugging and abandonment, degas tanks and platforms during workover operations, and to wash drill cuttings to remove oils and prevent sheens on surface waters.
3. Conditions for Use:
May be used with salt or fresh water. Temperature is not relevant.

VII. TOXICITY AND EFFECTIVENESS

a. Toxicity:

Material Tested	Species	LC50 (ppm)
BIOSOLVE®	Menidia beryllina Mysidopsis bahia	6.4 96-hr 3.6 48-hr
No. 2 Fuel Oil	Menidia beryllina Mysidopsis bahia	5.6 96-hr 2.7 48-hr
BIOSOLVE® & No. 2 Fuel Oil	Menidia beryllina Mysidopsis bahia	7.4 96-hr 1.3 48-hr
Reference Toxicant (DSS)	Menidia beryllina Mysidopsis bahia	7.2 96-hr 13.4 48-hr

NOTE: This toxicity data was derived using the concentrated product. See section VI of this bulletin for information regarding the manufacturer's recommendations for concentrations and application rates for field use.

b. Effectiveness:
NA

VIII. MICROBIOLOGICAL ANALYSIS

NA

IX. PHYSICAL PROPERTIES

(Liquid concentrate)
1. Flash Point: NA, Water based > 200°F (93.3°C)
2. Pour Point: 32.9°F (0.5°C)
3. Viscosity: 77.5 Centistrokes (concentrate), 490 centipoise (concentrate), 15 centipoise at 6%, at 60.08°F (15.6°C)
4. Specific Gravity: 1.025 at 60°F (15.5°C)
5. pH: 9.37 +/- .5
6. Surface Active Agents: CONFIDENTIAL
7. Solvents: CONFIDENTIAL
8. Additives: CONFIDENTIAL
9. Solubility: Complete-true solution formed with water

X. ANALYSIS FOR HEAVY METALS AND CHLORINATED HYDROCARBONS

Compound	Concentration (ppm)
Arsenic	ND < 0.2
Cadmium	ND < 0.18
Chromium	ND < 0.5
Copper	ND < 0.6
Lead	ND < 0.2
Mercury	ND < 0.07
Nickel	ND < 0.6
Silver	ND < 0.4
Zinc	0.51
Cyanide	ND < 0.01
Chlorinated Hydrocarbons	ND < 0.5

http://www.epa.gov/ceppo/web/content/ncp/products/clngrn.htm
Last updated on 01/27/2011

Emergency Management

CLEAN GREEN

TECHNICAL PRODUCT BULLETIN #SW-44
USEPA, OIL PROGRAM CENTER
ORIGINAL LISTING DATE: AUGUST 5, 2010
"CLEAN GREEN"

I. NAME, BRAND, OR TRADEMARK

CLEAN GREEN
(aka, CLEANGREEN® PLANET WASH)
Type of Product: Surface Washing Agent

II. NAME, ADDRESS, AND TELEPHONE NUMBER OF MANUFACTURER/CONTACT

U.S. AG, LLC
P.O. Box 368
Luthersville, GA 30251
Phone: (770) 927-3206
Fax: (770) 927-3968
E-mail: unitedstatesag@yahoo.com
Web Site: http://www.unitedstatesag.org
(Mr. Carl Schneider)

III. NAME, ADDRESS, AND TELEPHONE NUMBER OF PRIMARY DISTRIBUTORS

U.S. AG, LLC
56 N Main
Luthersville, GA 30251
Phone: (770) 927-3206
Fax: (770) 927-3968
E-mail: unitedstatesag@yahoo.com
Web Site: http://www.unitedstatesag.org
(Mr. Carl Schneider)

IV. SPECIAL HANDLING AND WORKER PRECAUTIONS FOR STORAGE AND FIELD APPLICATION

1. Flammability: Non-flammable (DOT: Non-hazardous)
2. Ventilation: No special requirements.
3. Skin and eye contact; protective clothing; treatment in case of contact: No special equipment or clothing required, however, goggles are recommended. If eye or skin irritation occurs, flush with plenty of fresh water.
4.a. Maximum storage temperature: 120°F continuous, 140°F up to 5 days
4.b. Minimum storage temperature: 35°F
4.c. Optimum storage temperature range: 40°F to 120°F
4.d. Temperatures of phase separations and chemical changes: Stable

V. SHELF LIFE

5 years in sealed polydrums or totes (as delivered).

VI. RECOMMENDED APPLICATION PROCEDURE

1. Application Method: Product may be applied to any oil coated surface, such as beaches, equipment, rocks, etc. A variety of pumps or sprayers may be used for direct application to contaminates, back-pack, drum pumps, pick-up sprayers, etc.
2. Concentration/Application Rate: Where ever higher oil concentrations occur use approximately a 1:10 dilution ratio (product:water). Lightly soiled areas will require a 1:10 to 1:30 ratio.
3. Conditions for Use: Residue from surface washing should be collected and disposed of according to local, state, and federal regulations. The collection of residue can be determined on a site by site basis based on best practices of the area.

VII. TOXICITY AND EFFECTIVENESS

a. Toxicity:

Material Tested	Species	LC50 (ppm)
CLEAN GREEN	Menidia beryllina Mysidopsis bahia	136.10 96-hr 70.70 48-hr
No. 2 Fuel Oil	Menidia beryllina Mysidopsis bahia	3.35 96-hr 2.24 48-hr
CLEAN GREEN & No. 2 Fuel Oil (1:10)	Menidia beryllina Mysidopsis bahia	4.73 96-hr 2.24 48-hr
Reference Toxicant (SLS)	Menidia beryllina Mysidopsis bahia	12.25 96-hr 10.53 48-hr

b. Effectiveness
NA

VIII. MICROBIOLOGICAL ANALYSIS

NA

IX. PHYSICAL PROPERTIES

1. Flash Point: >93°C
2. Pour Point: +25°F
3. Viscosity: 3.72 @40°C
4. Specific Gravity: 1.0691 @70°F
5. pH: 9.9
6. Surface Active Agents: CONFIDENTIAL
7. Solvents: CONFIDENTIAL
8. Additives: CONFIDENTIAL
9. Solubility: Miscible in oil, water, and solvents

X. ANALYSIS FOR HEAVY METALS, CYANIDE, AND CHLORINATED HYDROCARBONS	
Compound	Concentration (ppm)
Arsenic	0.0265
Cadmium	<0.005
Chromium	0.0985
Copper	<0.0150
Lead	<0.0100
Mercury	0.0005
Nickel	<0.0250
Zinc	0.2455
Cyanide	<0.300
Chlorinated Hydrocarbons	<5.0

http://www.epa.gov/ceppo/web/content/ncp/products/cytosol.htm
Last updated on 01/27/2011

Emergency Management

CYTOSOL

TECHNICAL PRODUCT BULLETIN #SW-19
US EPA, OIL PROGRAM CENTER
LISTING DATE: JANUARY 30, 1997
"CYTOSOL"

I. NAME, BRAND, OR TRADEMARK

CYTOSOL
Type of Product: Surface Washing Agent

II. NAME, ADDRESS, AND TELEPHONE NUMBER OF MANUFACTURER

CytoCulture International, Inc.
249 Tewksbury Avenue
Point Richmond, CA 94801-3829
Phone: (510) 233-0102
Fax: (510) 233-3777
Mobile: (561) 762-5440
Email First Response: vwedel@aol.com
Email: rvw@cytoculture.com
Website: http://www.cytoculture.com EXIT Disclaimer
(Dr. Randall von Wedel)

III. NAME, ADDRESS, AND TELEPHONE NUMBER OF PRIMARY DISTRIBUTORS

CytoCulture International, Inc.
249 Tewksbury Avenue
Point Richmond, CA 94801-3829
Phone: (510) 233-0102
Fax: (510) 233-3777
Mobile: (561) 762-5440
Email First Response: vwedel@aol.com
Email: rvw@cytoculture.com
Website: http://www.cytoculture.com EXIT Disclaimer
(Dr. Randall von Wedel)

Foss Environmental, Inc.
7440 West Marginal
Seattle, WA 98108-4141
Phone: (206) 768-1450
Fax: (206) 767-3460
(Mr. Larry Pintler)

Advanced Cleanup Tech. Inc
20928 Lamberton Ave.
Carson, CA 90810

Phone: (800) 334-2284
Fax: (310) 763-9076
(Mr. Walt Dorn)

IV. SPECIAL HANDLING AND WORKER PRECAUTIONS FOR STORAGE AND FIELD APPLICATION

1. Flammability:
Non-flammable. However, keep the product away from heat and avoid contact with strong oxidizing agents. Ensure proper disposal of product-saturated absorbants, rags, and combustible materials to avoid the possibility of spontaneous combustion.
2. Ventilation:
Product is not volatile. However, in the event of aerosol inhalation, immediately move victim to fresh air. If victim has stopped breathing, give artificial respiration, preferably by mouth to mouth. Get medical attention immediately.
3. Skin and eye contact; protective clothing; treatment in case of contact:
The CYTOSOL contains no volatile hydrocarbons or petroleum constituents. However, as a precautionary measure, wear gloves and safety glasses meeting the specifications of ANSI Standard Z87.1. Avoid breathing aerosols. Avoid prolonged contact with skin.
4. Storage:
a. Maximum storage temperature: 110°F
b. Minimum storage temperature: 39°F
c. Optimum storage temperature: 55°F
d. Temperatures of phase separations and chemical changes:
Avoid freezing. At temperatures below the cloud point (43°F), the product may become cloudy, but will return to normal upon warming, with no effect on performance. Store product in airtight containers, if possible, without excessive exposure to moisture.

V. SHELF LIFE:

Closed container: 10 years in a dry environment.
Open container: 1 year in a warm, humid environment.
The product does not deteriorate appreciably over time, but will grow bacteria if water condensation accumulates in the container.

VI. RECOMMENDED APPLICATION PROCEDURE

1. Application Method:
The CYTOSOL is applied to oiled shorelines to extract and recover weathered petroleum by flotation with passive water deluges from header pipes or manual spraying. Remaining residual hydrocarbons are biodegraded, either passively by intrinsic bioremediation, or aggressively by enhancing the process with controlled amounts of nutrients and/or acclimated cultures of bacteria cultured from the site, when approved by local, state and federal agencies. The CYTOSOL Process is most suitable for the treatment of heavily oiled shorelines that do not respond well to conventional treatments, or that are considered too sensitive for mechanical/pressure wash strategies. Prior to the application of CYTOSOL, collection booms, oil skimmers, sorbent pads, or other appropriate containment and collection mechanisms must be deployed and operational.
2. Concentration/Application Rate:
CYTOSOL may be applied with a variety of spraying or washing equipment, depending upon the scale and type of shoreline to be cleaned. The product is to be used only neat and undiluted, for direct application to spilled oil. For large beach areas, CYTOSOL can be sprayed from water trucks or work boats equipped with pumps, hoses, and nozzles to deliver the product as an aerial spray. In smaller applications, CYTOSOL may be applied with hand sprayers or portable pumps to spray the product directly onto oiled surfaces. Dose rates will vary with the type and amount of petroleum spilled, the extent of weathering, and other site specific conditions, including temperature, porosity of shoreline,

and residence time available to let the product contact the oil. In general, the ratio of applied CYTOSOL to crude oil is between 0.5:1 and 1:1. The quantity of CYTOSOL applied should be approximately equivalent to the quantity of petroleum accumulated on the shoreline, or as required to dissolve and remove weathered oil. After application, the product should be allowed to penetrate and dissolve the weathered petroleum for at least one hour, preferably longer. Cold weather applications will require more contact time before initiating recovery. In tidal areas, it is advisable to apply the CYTOSOL as the tide is ebbing (receding) to maximize contact time. Trapped oil may continue to be released for several days, requiring that containment devices be left in place.
3. Conditions for Use:
The following shoreline types are appropriate for the use of CYTOSOL: Coarse sand beaches where petroleum has penetrated into sand; marsh areas and vegetated wetlands where oil has coated plants and become trapped; concrete bulkheads, rip rap and piers that may have trapped oil; oiled pilings; gravel or cobble shorelines and rocky shores, where oil has become trapped in pockets; and, public beaches, fisheries, hatcheries, river banks, and other sensitive or high impact sites. The CYTOSOL has been field tested successfully for removing oil from mussel beds and intertidal zones, pilings and concrete rip rap. The CYTOSOL also proved effective in facilitating the removal of oil from the banks and vegetation along an oiled creek.

VII. TOXICITY AND EFFECTIVENESS

a. Toxicity:

Material Tested	Species	LC50 (ppm)
CYTOSOL	Menidia beryllina Mysidopsis bahia	738.0 96-hr 124.0 48-hr
No. 2 Fuel Oil	Menidia beryllina Mysidopsis bahia	38.9 96-hr 5.9 48-hr
CYTOSOL & No. 2 Fuel Oil (1:10)	Menidia beryllina Mysidopsis bahia	24.3 96-hr 7.0 48-hr
Reference Toxicant (DSS)	Menidia beryllina Mysidopsis bahia	13.8 96-hr 22.2 48-hr

NOTE: This toxicity data was derived with the EPA protocols for dispersants using a blender to emulsify the product into the water for testing organisms. The CYTOSOL emulsion created microdroplets of product which may have had direct physical effects on the test larvae. Since the solubility of the product in water is so low (14 ppm or less), it is probable that the observed effects on the test organisms was caused by larvae having direct contact with droplets of product rather than by a true chemical toxicity from the trace amount of dissolved product. In practice, the CYTOSOL would not be emulsified to any great extent during application. See Section VI of this bulletin for information regarding the manufacturer's recommendations for concentrations and application rates for field use.

b. Effectiveness:
NA

VIII. MICROBIOLOGICAL ANALYSIS

NA

IX. PHYSICAL PROPERTIES

1. Flash Point: 360°F
2. Pour Point: 10°F
3. Viscosity: 4.15 CST @ 104°F
4. Specific Gravity: 0.8877 @ 60°F
5. pH: Neutral
6. Surface Active Agents: None
7. Solvents: No Petroleum Distillates
8. Additives: CONFIDENTIAL
9. Solubility: 14 ppm in fresh water, 7 ppm in sea water

X. ANALYSIS FOR HEAVY METALS AND CHLORINATED HYDROCARBONS

Compound	Concentration (ppm)
Arsenic	ND
Cadmium	ND
Chromium	ND
Copper	ND
Lead	ND
Mercury	ND
Nickel	ND
Zinc	ND
Cyanide	ND
Chlorinated Hydrocarbons	ND

http://www.epa.gov/ceppo/web/content/ncp/products/desolvitsup.htm
Last updated on 01/27/2011

Emergency Management

DE-SOLV-IT CLEAN AWAY APC SUPER CONCENTRATE

TECHNICAL PRODUCT BULLETIN #SW-49
USEPA, OIL PROGRAM CENTER
ORIGINAL LISTING DATE: NOVEMBER 10, 2010
"DE-SOLV-IT CLEAN AWAY APC SUPER CONCENTRATE"

I. NAME, BRAND, OR TRADEMARK

DE-SOLV-IT CLEAN AWAY APC SUPER CONCENTRATE
Type of Product: Surface Washing Agent

II. NAME, ADDRESS, AND TELEPHONE NUMBER OF MANUFACTURER/CONTACT

Orange-Sol Blending and Packaging
1400 N Fiesta Boulevard
Gilbert, AZ 85233
Phone: (800) 877-7771
Fax: (480) 497-0444
E-mail: amf@orange-sol.com
Web Site: http://www.organge-sol.com
(Mr. Albert Farnsworth)
(Mr. Jack Farnsworth at (480) 319-0141)

III. NAME, ADDRESS, AND TELEPHONE NUMBER OF PRIMARY DISTRIBUTORS

Bell Tech
Master Distributor
P.O. Box 2198
Valdez, AK 99686
Phone: (907) 602-0111
Fax: (907) 835-4535
E-mail: bellenterprise@cvinternet.net
(Mr. Randy Bell)

IV. SPECIAL HANDLING AND WORKER PRECAUTIONS FOR STORAGE AND FIELD APPLICATION

1. Flammability: Non-combustible
2. Ventilation: No special requirements
3. Skin and eye contact; protective clothing; treatment in case of contact: No special equipment of clothing required; however, goggles are recommended where splash is potential. If eye or skin irritation occurs, flush with ample fresh water.
4.a. Maximum storage temperature: 210°F

4.b. Minimum storage temperature: 34°F
4.c. Optimum storage temperature range: 55°F to 90°F
4.d. Temperatures of phase separations and chemical changes: There are no known phase separations, chemical changes, or other altercations that will change the effectiveness of the product.

V. SHELF LIFE

Two (2) years in sealed drums or totes (as delivered).

VI. RECOMMENDED APPLICATION PROCEDURE

1. Application Method: DE-SOLV-IT CLEAN AWAY APC SUPER CONCENTRATE can be used on all oil coated surfaces including sand and rocks through a detergency mechanism. Product should be used with handheld sprayers or for larger applications applied with truck mounted sprayers. Remove contamination with DE-SOLV-IT CLEAN AWAY APC SUPER CONCENTRATE, followed by a rinse.
2. Concentration/Application Rate: For oil spill removal and heavy duty cleaning, dilute product with water using a 1:1 ratio.
3. Conditions for Use: DE-SOLV-IT CLEAN AWAY APC SUPER CONCENTRATE can be used in salt or fresh water, with no limitations as to usage within the optimum temperature parameters (application may be made at or above 35°F, with optimum above 48°F). Cleaning of oil soaked areas should be done in a contained area and residue should be collected. For sand or vegetation cleaning, a berm may be constructed down slope that will collect the residue for disposal. All disposal residues should be done according to federal, state, and local regulations. In general, the technique used for collection of the oil/soap residue should be determined by the on site contractor based on the environment of the area to be cleaned and the equipment and materials available for collection. Cleanup residue should be collected and disposed of in accordance with local, state, and federal regulations.

VII. TOXICITY AND EFFECTIVENESS

a. Toxicity:

Material Tested	Species	LC50 (ppm)
DE-SOLV-IT CLEAN AWAY APC SUPER CONCENTRATE	Menidia beryllina Mysidopsis bahia	20.95 96-hr 30.95 48-hr
No. 2 Fuel Oil	Menidia beryllina Mysidopsis bahia	4.07 96-hr 0.86 48-hr
DE-SOLV-IT CLEAN AWAY APC SUPER CONCENTRATE & No. 2 Fuel Oil (1:10)	Menidia beryllina Mysidopsis bahia	6.42 96-hr 0.69 48-hr

Reference Toxicant (SLS)	Menidia beryllina Mysidopsis bahia	12.04 96-hr 8.19 48-hr

b. Effectiveness:
NA

VIII. MICROBIOLOGICAL ANALYSIS

NA

IX. PHYSICAL PROPERTIES

1. Flash Point: >93°C
2. Pour Point: +20°F
3. Viscosity: 3.1 cst @ 40°C
4. Specific Gravity: 1.024 @60°F
5. pH: 9.03
6. Surface Active Agents: PROPRIETARY
7. Solvents: PROPRIETARY
8. Additives: Yes
9. Solubility: 100 percent

X. ANALYSIS FOR HEAVY METALS, CYANIDE, AND CHLORINATED HYDROCARBONS

Compound	Concentration (ppm)
Arsenic	<1.0
Cadmium	<0.5
Chromium	<0.5
Copper	<2.0
Lead	<1.0
Mercury	<0.005
Nickel	<1.0
Zinc	<2.5
Cyanide	0.08
Chlorinated Hydrocarbons	<0.05

http://www.epa.gov/ceppo/web/content/ncp/products/desolvit.htm
Last updated on 01/27/2011

Emergency Management

DE-SOLV-IT INDUSTRIAL FORMULA

TECHNICAL PRODUCT BULLETIN #SW-11 (formerly D-40)
USEPA, OIL PROGRAM CENTER
ORIGINAL LISTING DATE: JUNE 26, 1989
REMOVAL DATE: SEPTEMBER 15, 1994
RELISTING DATE: JULY 07, 2010
"DE-SOLV-IT INDUSTRIAL FORMULA"

I. NAME, BRAND, OR TRADEMARK

DE-SOLV-IT INDUSTRIAL FORMULA
Type of Product: Surface Washing Agent

II. NAME, ADDRESS, AND TELEPHONE NUMBER OF MANUFACTURER/CONTACT

Orange-Sol Blending and Packaging
1400 N Fiesta Boulevard
Gilbert, AZ 85233
Phone: (800) 877-7771
Fax: (480) 497-0444
E-mail: amf@orange-sol.com
Web Site: http://www.orange-sol.com
(Mr. Albert Farnsworth)
(Mr. Jack Farnsworth at (480) 319-0141)

III. NAME, ADDRESS, AND TELEPHONE NUMBER OF PRIMARY DISTRIBUTORS

Bell Tech
Master Distributor
P.O. Box 2198
Valdez, AK 99686
Phone: (907) 602-0111
Fax: (907) 835-4535
E-mail: bellenterprise@cvinternet.net
(Mr. Randy Bell)

IV. SPECIAL HANDLING AND WORKER PRECAUTIONS FOR STORAGE AND FIELD APPLICATION

1. Flammability: Non-flammable (DOT: Not regulated unless shipped by land in a package having a capacity of 3,500 gallons or more). Combustible Class IIIA per OSHA, 29 CFR 1910.106
2. Ventilation: No special requirements
3. Skin and eye contact; protective clothing; treatment in case of contact: No special equipment of clothing required; however, goggles are recommended where splash is potential. If eye or skin irritation occurs, flush with ample fresh water.
4.a. Maximum storage temperature: 120°F continuous, 140°F up to 5 days

4.b. Minimum storage temperature: -20°F
4.c. Optimum storage temperature range: 0°F to 120°F
4.d. Temperatures of phase separations and chemical changes: Stable

V. SHELF LIFE

Two (2) years in sealed polydrums or totes (as delivered).

VI. RECOMMENDED APPLICATION PROCEDURE

1. Application Method: DE-SOLV-IT (DSI) is to be used in neat form. DSI works just as well with fresh or salt water. This product works well with all types of oils. Product can be used on oil-contaminated beaches.
2. Concentration/Application Rate: Use DSI directly on the contaminated area, or up to approximately a 1:10 dilution ratio (product:water). Lighter oils will require a 1:10 to 1:30 product to water dilution ratio. Warmer waters (greater than 78°F) and/or good agitation during application will require less product. Response personnel can determine best method to collect clean up residue. Clean up residue should be collected and disposed of in accordance to local, state, and federal regulations.
3. Conditions for Use: Effective in salt or fresh water, with no limitations as to usage within optimum temperature parameters (application may be made at or above 35°F, with optimum above 48°F).

VII. TOXICITY AND EFFECTIVENESS

a. Toxicity:

Material Tested	Species	LC50 (ppm)
DE-SOLV-IT	Menidia beryllina Mysidopsis bahia	37.71 96-hr 4.57 48-hr
No. 2 Fuel Oil	Menidia beryllina Mysidopsis bahia	3.76 96-hr 2.04 48-hr
DE-SOLV-IT & No. 2 Fuel Oil (1:10)	Menidia beryllina Mysidopsis bahia	9.40 96-hr 1.68 48-hr
Reference Toxicant (SLS)	Menidia beryllina Mysidopsis bahia	12.25 96-hr 11.71 48-hr

b. Effectiveness:
NA

VIII. MICROBIOLOGICAL ANALYSIS

NA

IX. PHYSICAL PROPERTIES

1. Flash Point: 145°F
2. Pour Point: -84°F

3. Viscosity: 1.8 cst @ 40°C
4. Specific Gravity: 1.8345 @60°F
5. pH: 6.6
6. Surface Active Agents: Nonionic PROPRIETARY Surfactants
7. Solvents: PROPRIETARY
8. Additives: None
9. Solubility: Miscible in oil and solvents

X. ANALYSIS FOR HEAVY METALS, CYANIDE, AND CHLORINATED HYDROCARBONS

Compound	Concentration (ppm)
Arsenic	<0.010
Cadmium	<0.005
Chromium	<0.015
Copper	<0.015
Lead	<0.010
Mercury	<1 µg/L
Nickel	<0.025
Zinc	0.0.15
Cyanide	<0.010
Chlorinated Hydrocarbons	<6.00

http://www.epa.gov/ceppo/web/content/ncp/products/env1coc.htm
Last updated on 01/27/2011

Emergency Management

ENVIRONMENTAL 1 CRUDE OIL CLEANER

TECHNICAL PRODUCT BULLETIN #SW-47
USEPA, OIL PROGRAM CENTER
ORIGINAL LISTING DATE: AUGUST 25, 2010
"ENVIRONMENTAL 1 CRUDE OIL CLEANER"

I. NAME, BRAND, OR TRADEMARK

ENVIRONMENTAL 1 CRUDE OIL CLEANER
(aka, ENVIRONMENTAL 1 WASHING AGENT)
Type of Product: Surface Washing Agent

II. NAME, ADDRESS, AND TELEPHONE NUMBER OF MANUFACTURER/CONTACT

J and J Technology, LLC
3100 West End Avenue, Suite 450
Nashville, TN 37203
Phone: (615) 269-0506
Fax: (615) 269-0025
E-mail: info@environmental-one.com, Jdb@environmental-one.com
Web site: www.environmental-one.com
(Mr. Joe Blankenship, President/CEO)

III. NAME, ADDRESS, AND TELEPHONE NUMBER OF PRIMARY DISTRIBUTORS

J and J Technology, LLC
3100 West End Avenue, Suite 450
Nashville, TN 37203
Phone: (615) 269-0506
Fax: (615) 269-0025
E-mail: info@environmental-one.com, Jdb@environmental-one.com
Web site: www.environmental-one.com
(Mr. Joe Blankenship, President/CEO)

IV. SPECIAL HANDLING AND WORKER PRECAUTIONS FOR STORAGE AND FIELD APPLICATION

1. Flammability: Non-flammable, no hazards or restrictions
2. Ventilation: No special requirements.
3. Skin and eye contact; protective clothing; treatment in case of contact: No special equipment or clothing required, however goggles are recommended if used with a pressure washer. If eye or skin irritation occurs, flush with plenty of fresh water.
4.a. Maximum storage temperature: 140°F
4.b. Minimum storage temperature: 35°F
4.c. Optimum storage temperature range: 40°F to 120°F
4.d. Temperatures of phase separations and chemical changes: Stable

V. SHELF LIFE

Unlimited in sealed polydrums or totes (as delivered).

VI. RECOMMENDED APPLICATION PROCEDURE

ENVIRONMENTAL 1 CRUDE OIL CLEANER cleans oil from solid surfaces such as beaches, rocks, machines, buildings, tools, and other hard surfaces.

1. Spray ENVIRONMENTAL 1 CRUDE OIL CLEANER on oil surface to be cleaned with a drum pump sprayer or for smaller jobs use a hand pump sprayer.
2. On areas of heavy oil accumulation use product directly on the spill, or for areas of lighter accumulation use a 1:10 to 1:30 dilution ratio (product:water).
3. The oil and cleaner form a loose emulsion that can be rinsed away. Oil displaced from hard surfaces can be skimmed from the rinse water, absorbed with an oil absorbent, or removed via commercial waste removal.

May be used with fresh or salt water in normal climatic temperatures.

VII. TOXICITY AND EFFECTIVENESS

a. Toxicity:

Material Tested	Species	LC50 (ppm)
PRODUCT	Menidia beryllina Mysidopsis bahia	22.68 96-hr 16.27 48-hr
No. 2 Fuel Oil	Menidia beryllina Mysidopsis bahia	2.24 96-hr 0.99 48-hr
PRODUCT & No. 2 Fuel Oil (1:10)	Menidia beryllina Mysidopsis bahia	2.19 96-hr 0.43 48-hr
Reference Toxicant (SLS)	Menidia beryllina Mysidopsis bahia	12.25 96-hr 11.71 48-hr

b. Effectiveness
NA

VIII. MICROBIOLOGICAL ANALYSIS

NA

IX. PHYSICAL PROPERTIES

1. Flash Point: >93°C
2. Pour Point: +26.0°F
3. Viscosity: 3.34 cst @ 40°C
4. Specific Gravity: 1.01 @ 15°C
5. pH: 6.2
6. Surface Active Agents: Anionic, nonionic, zwitterionic surfactants
7. Solvents: None

8. Additives: Preservative
9. Solubility: Miscible in oil, water, and solvents

X. ANALYSIS FOR HEAVY METALS, CYANIDE, AND CHLORINATED HYDROCARBONS

Compound	Concentration (ppm)
Arsenic	0.0021
Cadmium	<0.0010
Chromium	<0.0030
Copper	<0.0030
Lead	<0.0020
Mercury	<0.0005
Nickel	<0.0050
Zinc	<0.0030
Cyanide	<0.010
Chlorinated Hydrocarbons	<5.00

http://www.epa.gov/ceppo/web/content/ncp/products/esafe.htm
Last updated on 01/27/2011

Emergency Management

E-SAFE©

TECHNICAL PRODUCT BULLETIN #SW-33
USEPA, OIL PROGRAM CENTER
ORIGINAL LISTING DATE: NOVEMBER 27, 2006
REVISED LISTING DATE:
"E-SAFE©"

I. NAME, BRAND, OR TRADEMARK

E-SAFE©
Type of Product: Surface Washing Agent

II. NAME, ADDRESS, AND TELEPHONE NUMBER OF MANUFACTURER/CONTACT

PLUTUS Environmental Technologies, Inc.
P.O. Box 5104
Sevierville, TN 37864-5104
Phone: (865) 453-0060
Fax: (865) 908-6652
Email: CEO@pluousonline.com
(Mr. James Hatcher)

III. NAME, ADDRESS, AND TELEPHONE NUMBER OF PRIMARY DISTRIBUTORS

PLUTUS Environmental Technologies, Inc.
P.O. Box 5104
Sevierville, TN 37864-5104
Phone: (865) 453-0060
Fax: (865) 908-6652
Email: CEO@pluousonline.com
(Mr. James Hatcher)

IV. SPECIAL HANDLING AND WORKER PRECAUTIONS FOR STORAGE AND FIELD APPLICATION

1. Flammability:
Non-flammable until >170°F
2. Ventilation:
Handle in a well ventilated space. Local exhaust is recommended if TLV's are exceeded.
3. Skin and eye contact; protective clothing; treatment in case of contact:
Avoid eye and (sensitive) skin contact. In case of contact, immediately flush with large amount of cool water of at least 5 minutes. Wear protective eye goggles when using any chemicals. Impermeable protective gloves are recommended for sensitive skin types. Protective clothing is not required. Rinse contaminated clothing, shoes, goggles, and gloves in simple tap water to remove any chemical residue. Avoid ingestion, breathing dusts,

mists, or fumes. In case of ingestion drink several glasses of water. Do not induce vomiting. In case of inhalation, move affected person to fresh air.
4.a. Maximum storage temperature: 160°F
4.b. Minimum storage temperature: -15°F
4.c. Optimum storage temperature range: 40°F – 110°F
4.d. Temperatures of phase separations and chemical changes: No phase separations will occur. Continued exposure to direct sunlight may cause a change in color, but performance is not affected.

V. SHELF LIFE

Unlimited if left in unopened containers stored at 40° - 110°F and away from direct sunlight.

VI. RECOMMENDED APPLICATION PROCEDURE

1. Application Method:
E-SAFE© may be introduced with a pressure spray to cover the affected area. The contaminated area should be thoroughly moistened. Following the spray application the treated area should be soaked with water to facilitate penetration. Heavy soil such as clay will be cleaned by E-SAFE©, but tilling or aerating the soil will rapidly shorten penetration time. Sand or loam ay require heavy dosage with E-SAFE© because hydrocarbon migration is so rapid in these soil types. Treatment of fouled beach areas should have E-SAFE© sprayed on all contaminated surfaces. Any remaining hydrocarbons may then be effectively vacuumed or wiped away from the treated surfaces. Incidental wave action or rainfall will enhance coverage and penetration by E-SAFE©.
2. Concentration/Application Rate:
E-SAFE© should be applied full strength. Beginning treatment for hydrocarbon contaminated surface is one gallon of E-SAFE© per 100 square foot of surface area. This dosage is recommended when the ambient temperature is 72°F and humidity is moderate. Higher temperature or lower humidity will increase the need for repeated applications or a higher volume of E-SAFE© per application.
3. Conditions for Use:
E-SAFE© works on all soil types and weather conditions that allow hydrocarbon penetration. E-SAFE© follows the same path, channel, or gradient as the contaminant. When visible detection reveals that E-SAFE© has been absorbed by, or has penetrated the soil, water should be applied to the site. E-SAFE© is soluble in water and also breaks the surface tension of the transporting water molecules.

VII. TOXICITY AND EFFECTIVENESS

a. Toxicity:

Material Tested	Species	LC50 (ppm)
E-SAFE©	Menidia beryllina Mysidopsis bahia	329.00 96-hr 257.00 48-hr
No. 2 Fuel Oil	Menidia beryllina Mysidopsis bahia	5.45 96-hr 10.20 48-hr
E-SAFE© No. 2 Fuel Oil (1:10)	Menidia beryllina Mysidopsis bahia	8.77 96-hr 14.20 48-hr

Reference Toxicant (SDS)	Menidia beryllina Mysidopsis bahia	8.07 96-hr 16.00 48-hr

b. Effectiveness:
NA

VIII. MICROBIOLOGICAL ANALYSIS

NA

IX. PHYSICAL PROPERTIES

1. Flash Point, ASTM D-93: >170°F
2. Pour Point, ASTM D-97: -27°C
3. Viscosity, ASTM D-88: 11SFS@ 100°F
4. Specific Gravity, ASTM D-1298: 1.0118 @ 60°F
5. pH: 8.04
6. Surface Active Agents: Confidential
7. Solvents: Confidential
8. Additives: Confidential
9. Solubility: Soluble

X. ANALYSIS FOR HEAVY METALS, CYANIDE, AND CHLORINATED HYDROCARBONS

Compound	Concentration (ppm)
Arsenic	<0.005
Cadmium	<0.0008
Chromium	<0.025
Copper	0.061
Lead	0.082
Mercury	<0.007
Nickel	<0.003
Zinc	0.214
Cyanide	0.200
Chlorinated Hydrocarbons	ND

http://www.epa.gov/ceppo/web/content/ncp/products/goldcrew.htm
Last updated on 01/27/2011

Emergency Management

GOLD CREW SW

TECHNICAL PRODUCT BULLETIN #SW-26
USEPA, OIL PROGRAM CENTER
ORIGINAL LISTING DATE: AUGUST 6, 2001
"GOLD CREW SW"

I. NAME, BRAND, OR TRADEMARK

GOLD CREW SW
Type of Product: Surface Washing Agent

II. NAME, ADDRESS, AND TELEPHONE NUMBER OF MANUFACTURER/CONTACT

Gold Crew Products & Services, LLC
P.O. Box 12032
Orange, CA 92869
Phone: (714) 288-8781
Fax: (714) 288-8730
Email: jfigueira@goldcrew.net
(Mr. Jim Figueira)

ECS
10421 Burnham Drive, NW Building 1-B
P.O. Box 2029
Gig Harbor, WA 98335
(Mr. Ed Grubbs)

III. NAME, ADDRESS, AND TELEPHONE NUMBER OF PRIMARY DISTRIBUTORS

Gold Crew Products & Services, LLC
P.O. Box 12032
Orange, CA 92869
Phone: (714) 288-8781
Fax: (714) 288-8730
Email: jfigueira@goldcrew.net
(Mr. Jim Figueira)

ECS
10421 Burnham Drive, NW

Building 1-B
P.O. Box 2029
Gig Harbor, WA 98335
(Mr. Ed Grubbs)

IV. SPECIAL HANDLING AND WORKER PRECAUTIONS FOR STORAGE AND FIELD APPLICATION

1. Flammability:
Non-flammable.
2. Ventilation:
Normal.
3. Skin and eye contact; protective clothing; treatment in case of contact: Extensive testing indicates that GOLD CREW SW is non-hazardous and non-toxic to humans; however, good hygiene practices should always be followed as outlined below: Eyes - flush with water; get medical attention if required; Skin - remove contaminated clothing, wash exposed area, and wash clothing before use. If irritation develops get medical attention; Ingestion - get medical attention if required; Inhalation - none considered necessary.
4.a. Maximum storage temperature: When above 120°F, keep container closed and stored in a cool dark place. Evaporation may change product's characteristics.
4.b. Minimum storage temperature: Product will freeze below 25°F. No phase separation will occur. If frozen, thaw, and stir well.
4.c. Optimum storage temperature range: 25°F to 120°F
4.d. Temperatures of phase separations and chemical changes: No separation at any temperature between 32 - 120°F. No tendency to "layer out" or separate, standing for 30 days. No separation of layering after freezing.

V. SHELF LIFE

20 years (unopened)

VI. RECOMMENDED APPLICATION PROCEDURE

1. Application Method:
Apply through hand pump sprayer and allow to soak
2. Concentration/Application Rate:
As a presoak dilute 20 parts water to 1 part SW. For crude oil, allow about 1 hour. For medium distillates, allow 30 minutes. For light distillates, allow 15 minutes. Time may very depending on weather conditions. After allowing the solution to presoak, wash the area in the following manner: Apply through a power washer or through a steam powered unit at 1 percent, 3 percent, or 5 percent depending on oil viscosity and temperature.
3. Conditions for Use:
Equally effective with salt or fresh water.

VII. TOXICIY AND EFFECTIVENESS

a. Toxicity:

Material Tested	Species	LC50 (ppm)
GOLD CREW SW	Menidia beryllina Mysidopsis bahia	13.80 96-hr 20.40 48-hr
No. 2 Fuel Oil	Menidia beryllina Mysidopsis bahia	6.75 96-hr 2.82 48-hr

GOLD CREW SW & No. 2 Fuel Oil (1:10)	Menidia beryllina Mysidopsis bahia	6.34 96-hr 2.70 48-hr
Reference Toxicant (SDS)	Menidia beryllina Mysidopsis bahia	2.22 96-hr 9.52 48-hr

b. Effectiveness:
NA

VIII. MICROBIOLOGICAL ANALYSIS

NA

IX. PHYSICAL PROPERTIES

1. Flash Point: >200
2. Pour Point: 25°F
3. Viscosity: 33.87 CST
4. Specific Gravity: 1.035
5. pH: 9.76 +/- 0.01
6. Surface Active Agents: Confidential
7. Solvents: None
8. Additives: Confidential
9. Solubility in Water: Complete

X. ANALYSIS FOR HEAVY METALS, CYANIDE, AND CHLORINATED HYDROCARBONS

Compound	Concentration (ppm)
Arsenic	<1.0
Cadmium	<0.10
Chromium	<1.0
Copper	<1.0
Lead	<0.5
Mercury	<0.02
Nickel	<1.0
Zinc	<0.44
Cyanide	ND
Chlorinated Hydrocarbons	ND

http://www.epa.gov/ceppo/web/content/ncp/products/naleit.htm
Last updated on 01/27/2011

Emergency Management

You are here: EPA Home Emergency Management NCP Subpart J NCP Product Schedule NALE-IT

NALE-IT

TECHNICAL PRODUCT BULLETIN #SW-28
USEPA, OIL PROGRAM CENTER
LISTING DATE: NOVEMBER 05, 2001
"NALE-IT"

I. NAME, BRAND, OR TRADEMARK

NALE-IT
Type of Product: Surface Washing Agent

II. NAME, ADDRESS, AND TELEPHONE NUMBER OF MANUFACTURER/CONTACT

SPL Control LLC
P.O. Box 627
Elemore City, OK 73433
Phone: (580) 788-2187
Email: splcontorl@aol.com
(Mr. Tom Lester)

III. NAME, ADDRESS, AND TELEPHONE NUMBER OF PRIMARY DISTRIBUTORS

SPL Control LLC
P.O. Box 627
Elemore City, OK 73433
Phone: (580) 788-2187
Email: splcontorl@aol.com
(Mr. Tom Lester)

IV. SPECIAL HANDLING AND WORKER PRECAUTIONS FOR STORAGE AND FIELD APPLICATION

1. Flammability:
Non-flammable
2. Ventilation:
Workers should be in well ventilated areas; if in a confined area, use a respirator.
3. Skin and eye contact; protective clothing; treatment in case of contact:
Workers should wear protective goggles or safety glasses. Prolonged contact with skinn may result in dryness.
4.a. Maximum storage temperature: NA
4.b. Minimum storage temperature: >32°F
4.c. Optimum storage temperature range : 40°F to 200°F
4.d. Temperatures of phase separations and chemical changes: No phase separation or hazardous polymerization will occur.

V. SHELF LIFE

Indefinite.

VI. RECOMMENDED APPLICATION PROCEDURE

1. Application Method:
NALE-IT may be applied using a pressure sprayer.
2. Concentration/Application Rate:
For pit closures, surface hydrocarbon spills, compressor stations, pipeline and flow line leaks, well head and tank farm leaks, and highway spills (petroleum products) mix 1 part NALE-IT with 20 parts water.
3. Conditions for Use:
Equally effective with fresh or salt water.

VII. TOXICIY AND EFFECTIVENESS

a. Toxicity:

Material Tested	Species	LC50 (ppm)
NALE-IT	Menidia beryllina Mysidopsis bahia	273.30 96-hr 69.00 48-hr
No. 2 Fuel Oil	Menidia beryllina Mysidopsis bahia	6.93 96-hr 2.29 48-hr
NALE-IT & No. 2 Fuel Oil (1:10)	Menidia beryllina Mysidopsis bahia	3.82 96-hr 1.84 48-hr
Reference Toxicant (SDS)	Menidia beryllina Mysidopsis bahia	2.60 96-hr 8.56 48-hr

b. Effectiveness:
NA

VIII. MICROBIOLOGICAL ANALYSIS

NA

IX. PHYSICAL PROPERTIES

1. Flash Point: >212°F
2. Pour Point: 30°F
3. Viscosity: 1.18
4. Specific Gravity: 1.02
5. pH: 6.8 - 7.2
6. Surface Active Agents: CONFIDENTIAL
7. Solvents: None
8. Additives: CONFIDENTIAL
9. Solubility in water: Soluble in fresh and salt water

X. ANALYSIS FOR HEAVY METALS, CYANIDES, AND CHLORINATED HYDROCARBONS

Compound	Concentration (ppm)
Arsenic	0.82
Cadmium	ND
Chromium	ND
Copper	0.173
Lead	ND
Mercury	ND
Nickel	ND
Zinc	0.18
Cyanide	ND
Chlorinated Hydrocarbons	ND

http://www.epa.gov/ceppo/web/content/ncp/products/petrocle.htm
Last updated on 01/27/2011

Emergency Management

PETRO-CLEAN

TECHNICAL PRODUCT BULLETIN #SW-23
USEPA, OIL PROGRAM CENTER
ORIGINAL LISTING DATE: MARCH 1, 1999
REVISED LISTING DATE:
"PETRO-CLEAN "

I. NAME, BRAND, OR TRADEMARK

PETRO-CLEAN
Type of Product: Surface Washing Agent

II. NAME, ADDRESS, AND TELEPHONE NUMBER OF MANUFACTURER/CONTACT

Alabaster Corp.
6921 Olson Lane
Pasadena, Texas 77505
Phone: (281) 487-5482 or 1 (800) 609-2728
Fax: (281) 487-9014
Email: alabastercorp@aol.com
(Mr. Charles Sheffield)

III. NAME, ADDRESS, AND TELEPHONE NUMBER OF PRIMARY DISTRIBUTORS

Alabaster Corp.
6921 Olson Lane
Pasadena, Texas 77505
Phone: (281) 487-5482 or (800) 609-2728
Fax: (281) 487-9014
Email: alabastercorp@aol.com
(Mr. Charles Sheffield)

Four Alarm Fire Equipment
P.O. Box 448
South Houston, Texas 77587
Phone: (713) 948-0484
Fax: (713) 910-3300

A.N. Rusche Distributing Company
9223 Eastex Freeway
Houston, Texas 77093

Garner Environmental Services, Inc.
1717 West 13th. St.
Deer Park, Texas 7736
Phone: (281) 930-1200
Fax: (281) 478-0296

Website: www.garner-es.com EXIT Disclaimer

Garner Environmental Services, Inc.
3197 Main Street
LaMarque, Texas 77568
Phone: (800) 935-0308
Fax: (409) 935-0678
(Mr. Jack Campbell)

IV. SPECIAL HANDLING AND WORKER PRECAUTIONS FOR STORAGE AND FIELD APPLICATION

1. Flammability: Non-flammable
2. Ventilation: Normal
3. Skin and eye contact; protective clothing; treatment in case of contact:
Eyes - flush with water using eye cup of fountain for 15 minutes. Seek medical attention if irritation persists. Wash contaminated clothing and footwear before reuse. Ingestion - seek medical attention. Inhalation - no medical attention is required.
4.a. Maximum storage temperature: 120°F
4.b. Minimum storage temperature: 35°F
4.c. Optimum storage temperature range:
4.d. Temperatures of phase separations and chemical changes: None

V. SHELF LIFE

Indefinite when stored properly.

VI. RECOMMENDED APPLICATION PROCEDURE

1. Application Method: PETRO-CLEAN is applied through power washers or even garden type sprayers in light dilution is very effective in removing petrochemical hydrocarbons from rocks, shorelines, sea walls, bridges, and highways. In wetland applications, PETRO-CLEAN prevents hydrocarbons from attaching to grasses, trees, rocks, etc.
2. Concentration/Application Rate: Dilute or use eductors to specified rate and apply through fire hose, power washers, or sprayers to contaminated area. PETRO-CLEAN is a highly concentrated product and must be diluted before use. Dilution ratios vary depending on the specific conditions of the contaminated site. Normal recommended dilutions are from 0.5% to 6%. On heavy or weathered crude, pre-soaking with 6% may be necessary. For light or refined products, apply as 3% to 6% solution. For sheens on water apply a 0.5% to 1.0% solution.
3. Conditions for Use: May be used with salt or fresh water

VII. TOXICIY AND EFFECTIVENESS

a. Toxicity:

Material Tested	Species	LC50 (ppm)
PETRO-CLEAN	Menidia beryllina Mysidopsis bahia	100 96-hr 110 48-hr
No. 2 Fuel Oil	Menidia beryllina Mysidopsis bahia	110 96-hr 110 48-hr
PETRO-CLEAN & No. 2 Fuel Oil	Menidia beryllina Mysidopsis bahia	115 96-hr 105 48-hr

Material Tested	Species	LC50 (ppm)
Reference Toxicant (DSS)	Menidia beryllina Mysidopsis bahia	1.14 96-hr 0.98 48-hr

b. Effectiveness:
NA

VIII. MIROBIOLOGICAL ANALYSIS

NA

IX.PHYSICAL PROPERTIES

1. Flash Point: > 200°F
2. Pour Point: -17°F
3. Viscosity: 1.26 at 75°F
4. Specific Gravity: 0.99 at 75°F
5. pH: 8.05 (10% solution, s.u.)
6. Surface Active Agents: CONFIDENTIAL
7. Solvents: None
8. Additives: CONFIDENTIAL
9. Solubility in Water: 100 percent

X. ANALYSIS FOR HEAVY METALS, CYANIDE, AND CHLORINATED HYDROCARBONS

Compound	Concentration (ppm)
Arsenic	< 0.10
Barium	< 0.10
Cadmium	< 0.10
Chromium	< 0.01
Lead	< 0.002
Mercury	< 0.01
Silver	< 0.01
Selenium	< 0.01
Cyanide	< 2.0
Chlorinated Hydrocarbons	< 1.0

http://www.epa.gov/ceppo/web/content/ncp/products/procleans.htm
Last updated on 01/27/2011

Emergency Management

PROCLEANS

TECHNICAL PRODUCT BULLETIN #SW-35
USEPA OIL PROGRAM CENTER
ORIGINAL LISTING DATE: JUNE 16, 2008
"PROCLEANS"

I. NAME, BRAND, OR TRADEMARK

PROCLEANS
Type of Product: Surface Washing Agent

II. NAME, ADDRESS, AND TELEPHONE NUMBER OF MANUFACTURER/CONTACT

Eximco International, Inc
5252 Gulfton, #2-B
Houston, TX 77081
Phone: (713) 432-7889
Email: procleans@procleans.com
(Mr. Nat Brown)

III. NAME, ADDRESS, AND TELEPHONE NUMBER OF PRIMARY DISTRIBUTORS

Eximco International, Inc.
5252 Gulfton, #2-B
Houston, TX 77081
Phone: (713) 432-7889
Email: procleans@procleans.com
(Mr. Nat Brown)

IV. SPECIAL HANDLING AND WORKER PRECAUTIONS FOR STORAGE AND FIELD APPLICATION

1. Flammability: Non-flammable.
2. Ventilation: Normal.
3. Skin and eye contact; protective covering; treatment in case of contact: Flush contaminated eyes thoroughly with water for 15 minutes, and get medical attention. Remove contaminated clothing, wash exposed area with soap and water, and wash clothing before use. Get medical attention if irritation develops. Get medical attention if ingested. No medical attention is necessary if inhaled.
4.a. Maximum storage temperature: 130°F
4.b. Minimum storage temperature: 35°F
4.c. Optimum storage temperature range: 50-100°F
4.d. Temperatures of phase separations and chemical changes: NA

V. SHELF LIFE

Approximately 2 years at recommended temperatures if unopened.

VI. RECOMMENDED APPLICATION PROCEDURE

1. Application Method:
Apply specified dilute solution using fire hoses or heated pressure washers onto the contaminated solid surface of the spill.
2. Concentration/Application Rate:
Use ten parts water to one part product. Dilution rates may be adjusted to suit different job conditions. Apply 10 to 15 gallons of diluted PROCLEANS to one cubic yards of contamination.
3. Conditions for Use:
May be used with fresh or salt water. Warmer temperatures may improve results. Most effective if used on solid surfaces such as shoreline beaches and rocks contaminated with light and medium weight crude oils and refined petroleum products.

VII. TOXICITY AND EFFECTIVENESS

a. Toxicity:

Material Tested	Species	LC50 (ppm)
PROCLEANS	Menidia beryllina Mysidopsis bahia	83.73 96-hr 83.98 48-hr
No. 2 Fuel Oil	Menidia beryllina Mysidopsis bahia	7.41 96-hr 11.68 48-hr
PROCLEANS & No. 2 Fuel Oil (1:10)	Menidia beryllina Mysidopsis bahia	4.78 96-hr 11.68 48-hr
Reference Toxicant (DSS)	Menidia beryllina Mysidopsis bahia	0.73 96-hr 0.77 48-hr

b. Effectiveness:
NA

VIII. MICROBIOLOGICAL ANALYSIS

NA

IX. PHYSICAL PROPERTIES

1. Flash Point: >186°F
2. Pour Point: 34.6°F
3. Viscosity: 2.41 cST at 104°F
4. Specific Gravity: 1.01 at 25°C
5. pH: 6.8
6. Surface Active Agents: Anionic and nonionic
7. Solvents: None
8. Additives: None
9. Solubility in Water: NA

X. ANALYSIS FOR HEAVY METALS, CYANIDE, AND CHLORINATED HYDROCARBONS

Compound	Concentration (ppm)
Arsenic	0.690
Cadmium	ND
Chromium	ND
Copper	ND
Lead	ND
Mercury	ND
Nickel	ND
Zinc	0.738
Cyanide	ND
Chlorinated Hydrocarbons	ND

http://www.epa.gov/ceppo/web/content/ncp/products/sc1000.htm
Last updated on 01/27/2011

Emergency Management

SC-1000™

TECHNICAL PRODUCT BULLETIN #SW-25
USEPA, OIL PROGRAM CENTER
ORIGINAL LISTING DATE: JULY 9, 2001
"SC-1000™"

I. NAME, BRAND, OR TRADEMARK

SC-1000™
Type of Product: Surface Washing Agent

II. NAME, ADDRESS, AND TELEPHONE NUMBER OF MANUFACTURER/CONTACT

GEMTEK® Products
3808 North 28th Avenue
Phoenix, AZ 85017
Emergency Number: (602) 265-8586 or
Phone: (800) 331-7022
Fax: (602) 265-7241
Email: techsupport@infogemtek.com
(Ms. Kim Kristoff)

III. NAME, ADDRESS, AND TELEPHONE NUMBER OF PRIMARY DISTRIBUTORS

GEMTEK® Products
3808 North 28th Avenue
Phoenix, AZ 85017
Emergency Number: (602) 265-8586 or
Phone: (800) 331-7022
Fax: (602) 265-7241
Email: techsupport@infogemtek.com
(Ms. Kim Kristoff)

IV. SPECIAL HANDLING AND WORKER PRECAUTIONS FOR STORAGE AND FIELD APPLICATION

1. Flammability:
Non-flammable.
2. Ventilation:
General room ventilation is satisfactory.
3. Skin and eye contact; protective clothing; treatment in case of contact: Non-irritating, no first aid needed. May be an eye irritant. Do not spray into eyes; safety glasses are recommended. If irritation does occur, rinse thoroughly with water.
4.a. Maximum storage temperature: None
4.b. Minimum storage temperature: Room temperature
4.c. Optimum storage temperature range: 70ºF to 90ºF

4.d. Temperatures of phase separations and chemical changes: Low temperature can cause handling problems; viscosity of material will increase. The product is an organic compound and it will not typically stratify. The cloud point is 54°F. At 212°F it will boil and at somewhat less (around 130°F) water vapor will form. Repeat freeze/thaw/boiling cycles over a 30-day period has not demonstrated noticeable break down of the product.

V. SHELF LIFE

Minimum of 5 years

VI. RECOMMENDED APPLICATION PROCEDURE

1. Application Method: SC-1000™ is a highly concentrated cleaning compound capable of a multitude of cleaning applications with dilution ranging from full strength to far in excess of 1:350. Depending on the specific factors in the cleaning environment, the desired cleaning speed with the least amound of SC-1000™ can be determined. When diluting, it is recommended that SC-1000™ be added to premeasured water to minimize foaming in the solution.
2. Concentration/Application Rate:
Beach Waterfront, Rocky Soils, Break Water Sructures, and Pier Facilities: For beach sands or light rocky soils, burnin or creating a temporary shallow wash tank is most successful. Fill one-half of the tank with contaminated beach sand, then add a solution of SC-1000™ and clean water (ocean or fresh) to cover the sand. Gentle agitation will release the oil to the surface of the tank where it can be collected. For rocky surfaces spray with a 20 percent solution of SC-1000™ using a horizontal eductor sprayer, spraying side-to-side, allowing the soil to dwell for several minutes before spraying top-to-bottom with clean ocean or fresh water to rinse oil into perimeter oil booms, blankets or impermeable sheeting.
Washing Marine Vegetation: Use a non-pressure/impact spraying equipment to dispense a 0.01 percent SC-1000™ solution and allow to stand for 5-10 minutes before a final rinsing with fresh or ocean water.
Washing Marine Equipment: For wet oils and bunker crude, use SC-1000™ at 20 percent solution (preferably warmer than 80°F) and spray or wipe. apply directly to equipment, allow to swell for 1-2 minutes and then spray rinse with fresh or ocean water. For hardened oils, fuels, and viscous lubricants, apply SC-1000™ blended with SC-Supersolve™ (a non-toxic, low aromatic, water miscible solvent) at the ration of 80/20 then dilute with water to a 50 percent solution, spray or wipe onto surface, let stand for 1-2 minutes before rinsing.
Heavy Cleaning Examples: Dilution full strength 1:5, diesel engines, auto parts, baked on oil or lube grease, dried oil/enamel, latex paints, thick food syrups, insect smears, dried animal or vegetable fats, hard resins, thick dust-laden oily dirt, asphalt and grass or plant stains.
Average Cleaning Examples: Dilution 1:5 up to 1:20; automotive work counters and tools, food and beverage processing equipment, oily or food-laden floors, manufacturing work areas, vehicle maintenance, shipping containers, utility equipment, and parts washers.
General Maintenance Examples: 1:20 up to 1:100; vehicle washing, general janitorial for offices/schools/hospitals/recreation and related equipment, pressure sprayers, food preparation and storage, painted/plastic laminated surfaces, sports equipment, general cleaning, immersion tanks, and ultrasonics.
3. Conditions for Use:
SC-1000™ may be used on any surface that is compatible with water. The product may tarnish some soft aluminum surfaces if not adequately diluted and rinsed with water.

VII. TOXICIY AND EFFECTIVENESS

a. Toxicity:

Material Tested	Species	LC50 (ppm)
SC-1000™	Menidia beryllina Mysidopsis bahia	26.40 96-hr 15.20 48-hr
No. 2 Fuel Oil	Menidia beryllina Mysidopsis bahia	8.85 96-hr 1.57 48-hr
SC-1000™ & No. 2 Fuel Oil (1:10)	Menidia beryllina Mysidopsis bahia	4.72 96-hr 2.13 48-hr
Reference Toxicant (SDS)	Menidia beryllina Mysidopsis bahia	2.22 96-hr 10.50 48-hr

b. Effectiveness:
NA

VIII. MICROBIOLOGICAL ANALYSIS

NA

IX. PHYSICAL PROPERTIES

1. Flash Point: >212°F
2. Pour Point: 25°F
3. Viscosity: <10 cps @ 25°C
4. Specific Gravity: 1.009
5. pH: 10.2 - 10.5
6. Surface Active Agents: Confidential
7. Solvents: None
8. Additives: Confidential
9. Solubility in Water: Soluble in water

X. ANALYSIS FOR HEAVY METALS, CYANIDE, AND CHLORINATED HYDROCARBONS

Compound	Concentration (ppm)
Arsenic	1.33
Cadmium	ND
Chromium	ND
Copper	0.100
Lead	ND
Mercury	ND
Nickel	ND
Zinc	0.20
Cyanide	ND
Chlorinated Hydrocarbons	ND

http://www.epa.gov/ceppo/web/content/ncp/products/procleans.htm
Last updated on 01/27/2011

Emergency Management

PROCLEANS

TECHNICAL PRODUCT BULLETIN #SW-35
USEPA OIL PROGRAM CENTER
ORIGINAL LISTING DATE: JUNE 16, 2008
"PROCLEANS"

I. NAME, BRAND, OR TRADEMARK

PROCLEANS
Type of Product: Surface Washing Agent

II. NAME, ADDRESS, AND TELEPHONE NUMBER OF MANUFACTURER/CONTACT

Eximco International, Inc
5252 Gulfton, #2-B
Houston, TX 77081
Phone: (713) 432-7889
Email: procleans@procleans.com
(Mr. Nat Brown)

III. NAME, ADDRESS, AND TELEPHONE NUMBER OF PRIMARY DISTRIBUTORS

Eximco International, Inc.
5252 Gulfton, #2-B
Houston, TX 77081
Phone: (713) 432-7889
Email: procleans@procleans.com
(Mr. Nat Brown)

IV. SPECIAL HANDLING AND WORKER PRECAUTIONS FOR STORAGE AND FIELD APPLICATION

1. Flammability: Non-flammable.
2. Ventilation: Normal.
3. Skin and eye contact; protective covering; treatment in case of contact: Flush contaminated eyes thoroughly with water for 15 minutes, and get medical attention. Remove contaminated clothing, wash exposed area with soap and water, and wash clothing before use. Get medical attention if irritation develops. Get medical attention if ingested. No medical attention is necessary if inhaled.
4.a. Maximum storage temperature: 130°F
4.b. Minimum storage temperature: 35°F
4.c. Optimum storage temperature range: 50-100°F
4.d. Temperatures of phase separations and chemical changes: NA

V. SHELF LIFE

Approximately 2 years at recommended temperatures if unopened.

VI. RECOMMENDED APPLICATION PROCEDURE

1. Application Method:
Apply specified dilute solution using fire hoses or heated pressure washers onto the contaminated solid surface of the spill.
2. Concentration/Application Rate:
Use ten parts water to one part product. Dilution rates may be adjusted to suit different job conditions. Apply 10 to 15 gallons of diluted PROCLEANS to one cubic yards of contamination.
3. Conditions for Use:
May be used with fresh or salt water. Warmer temperatures may improve results. Most effective if used on solid surfaces such as shoreline beaches and rocks contaminated with light and medium weight crude oils and refined petroleum products.

VII. TOXICITY AND EFFECTIVENESS

a. Toxicity:

Material Tested	Species	LC50 (ppm)
PROCLEANS	Menidia beryllina Mysidopsis bahia	83.73 96-hr 83.98 48-hr
No. 2 Fuel Oil	Menidia beryllina Mysidopsis bahia	7.41 96-hr 11.68 48-hr
PROCLEANS & No. 2 Fuel Oil (1:10)	Menidia beryllina Mysidopsis bahia	4.78 96-hr 11.68 48-hr
Reference Toxicant (DSS)	Menidia beryllina Mysidopsis bahia	0.73 96-hr 0.77 48-hr

b. Effectiveness:
NA

VIII. MICROBIOLOGICAL ANALYSIS

NA

IX. PHYSICAL PROPERTIES

1. Flash Point: >186°F
2. Pour Point: 34.6°F
3. Viscosity: 2.41 cST at 104°F
4. Specific Gravity: 1.01 at 25°C
5. pH: 6.8
6. Surface Active Agents: Anionic and nonionic
7. Solvents: None
8. Additives: None
9. Solubility in Water: NA

X. ANALYSIS FOR HEAVY METALS, CYANIDE, AND CHLORINATED HYDROCARBONS

Compound	Concentration (ppm)
Arsenic	0.690
Cadmium	ND
Chromium	ND
Copper	ND
Lead	ND
Mercury	ND
Nickel	ND
Zinc	0.738
Cyanide	ND
Chlorinated Hydrocarbons	ND

Appendix C: Material Safety Data Sheets (MSDS)

MATERIAL SAFETY DATA SHEET

THE BIOSOLVE® COMPANY
329 Massachusetts Avenue
Lexington, Massachusetts 02420 USA

Ref. No.: 2001
Date: 7/26/2010

Phone: +1 (781) 482-7900 Fax: +1 (781) 482-7909
Emergency Phone-24 Hours: +1 (800) 225-3909

E-Mail: info@biosolve.com
Web Site: www.biosolve.com

SECTION I - IDENTITY

Name:	BioSolve®
CAS #:	138757-63-8
Formula:	Proprietary
Chemical Family:	Water Based, Biodegradable, Wetting Agents & Surfactants
HMIS Code:	Health 1, Fire 0, Reactivity 0
HMIS Key:	4 = Extreme, 3 = High, 2 = Moderate, 1 = Slight, 0 = Insignificant

SECTION II - HAZARDOUS INGREDIENTS

Massachusetts Right to Know Law or 29 C.F.R. (Code of Federal Regulations) 1910.1000 require listing of hazardous ingredients.

This product does not contain any hazardous ingredients as defined by CERCLA, Massachusetts Right to Know Law and California's Prop. 65.

DOT Class: Not Regulated/Non Hazardous

SECTION III - PHYSICAL - CHEMICAL CHARACTERISTICS

Boiling Point	: 265°F	Specific Gravity	: 1.00 +/-.01
Melting Point	: 32°F	Vapor Pressure mm/Hg	: Not Applicable
Surface Tension- 6% Solution	: 29.1 Dyne/cm at 25°C	Vapor Density Air = 1	: Not Applicable
Reactivity with Water	: No	Viscosity - Concentrate	: 490 Centipoise
Evaporation Rate	: >1 as compared to Water	Viscosity - 6% Solution	: 15 Centipoise
Appearance	: Clear Liquid unless Dyed	Solubility in Water	: Complete
Odor	: Pleasant Fragrance	pH	: 9.1+/-.3
Pounds per Gallon	: 8.38		

SECTION IV - FIRE AND EXPLOSION DATA

Special Fire Fighting Procedures	: None	Flammable Limit	: None
Unusual Fire and Explosion Hazards	: None	Auto Ignite Temperature	: None
Solvent for Clean-Up	: Water	Fire Extinguisher Media	: Not Applicable
Flash Point	: None		

SECTION V - SPECIAL PRECAUTIONS AND SPILL/LEAK PROCEDURES

Precautions to be taken in Handling and Storage: Use good normal hygiene.
Precautions to be taken in case of Spill or Leak -

Small spills, in an undiluted form, contain. Soak up with absorbent materials.
Large spills, in an undiluted form, dike and contain. Remove with vacuum truck or pump to storage/salvage vessel. Soak up residue with absorbent materials.

Waste Disposal Procedures -

Dispose in an approved disposal area or in a manner which complies with all local, provincial, and federal regulations.

SECTION VI - HEALTH HAZARDS

Threshold Limit Values: Not applicable
Signs and Symptoms of Over Exposure-

Acute : Moderate eye irritation. Skin: Causes redness, edema, drying of skin.
Chronic: Pre-existing skin and eye disorders may be aggravated by contact with this product.

Medical Conditions Generally Aggravated by Exposure: Unknown
Carcinogen: No
Emergency First Aid Procedures -

Eyes: Flush thoroughly with water for 15 minutes. Get medical attention.
Skin: Remove contaminated clothing. Wash exposed areas with soap and water. Wash clothing before reuse. Get medical attention if irritation develops.
Ingestion: Get medical attention.
Inhalation: None considered necessary.

SECTION VII - SPECIAL PROTECTION INFORMATION

Respiratory Protection	: Not necessary	Local Exhaust Required	: No, except in confined space as required.
Ventilation Required	: Normal	Protective Clothing	: Neoprene or other chemical resistant gloves, safety goggles or chemical face shield. Wash clothing before reuse.

WHEN UTILIZED IN CONFINED SPACE OPERATIONS, ADDITIONAL PPE MAY BE REQUIRED AS PER OSHA GUIDELINES.

SECTION VIII - PHYSICAL HAZARDS

Stability	: Stable	Incompatible Substances	: None Known
Polymerization	: No	Hazardous Decomposition Products	: None Known

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SECTION IX - TRANSPORT & STORAGE

DOT Class	: Not Regulated/Non Hazardous		
Freeze Temperature	: 28°F	Storage	: 35°F-120°F
Freeze Harm	: None (thaw & stir)	Shelf Life	: Unlimited Unopened

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SECTION X - REGULATORY INFORMATION

The Information on this Material Safety Data Sheet reflects the latest information and data that we have on hazards, properties, and handling of this product under the recommended conditions of use. Any use of this product or method of application, which is not described on the Product label or in this Material Safety Data Sheet, is the sole responsibility of the user. This Material Safety Data Sheet was prepared to comply with the OSHA Hazardous Communication Regulation and Massachusetts Right to Know Law.

MATERIAL SAFETY DATA SHEET
for
CytoSol Biosolvent

EMERGENCY PHONE: 1-510-233-0102
MSDS REFERENCE: **CytoCulture International, Inc.**

SECTION I - IDENTIFICATION

PRODUCT:	**CytoSol Biosolvent** proprietary formulation includes methyl esters
SYNONYMS:	Formulation of methyl esters of plant (soy) oil and macronutrients
CAS NO.:	None
SARA HAZARD:	None noted (Section 311/312) Title III Section 313 - Not Listed
DOT Regs:	Not regulated by DOT.

SECTION II - INGREDIENTS AND HAZARD CLASSIFICATION

COMPOSITION (Typical)	PEL/TLV	HAZARD
METHYL ESTERS	NONE/NONE	NONE NOTED

PCBs: Not detected at or above reporting limit of 800µg/kg

METALS ANALYSIS	RESULTS (mg/kg)	REPORTING LIMIT (mg/kg)
ARSENIC	ND	2.4
CADMIUM	ND	0.24
CHROMIUM (Total)	ND	0.49
COPPER	ND	0.49
LEAD	ND	4.9
MERCURY	ND	0.091
NICKEL	ND	0.97
ZINC	ND	0.97

SECTION III - HEALTH INFORMATION

INHALATION:	UNKNOWN - NONE SUSPECTED
INGESTION:	LD_{50}>50 ML/KG (ALBINO RATS) (SIMILAR PRODUCTS)
EYE CONTACT:	SIMILAR PRODUCTS WERE NOT CLASSIFIED AS EYE IRRITANTS.
SKIN CONTACT:	METHYL SOYATE WAS NOT CLASSIFIED AS A PRIMARY SKIN IRRITANT OR CORROSIVE MATERIAL.

SECTION IV - OCCUPATIONAL EXPOSURE LIMITS

PEL:	NO OSHA PEL
TLV:	NO ACGTH TLV

SECTION V - EMERGENCY FIRST AID PROCEDURES

FOR OVEREXPOSURE BY SWALLOWING:	Non-toxic, however, call a physician promptly.
FOR OVEREXPOSURE BY SKIN CONTACT:	Non-irritating, but wash affected area with soap & water.
FOR OVEREXPOSURE BY EYE CONTACT:	Immediately flush eyes with plenty of cool water for at least 15 minutes. Do not let victim rub eyes.
FOR OVEREXPOSURE BY INHALATION:	Non-irritating and non-toxic, but immediately remove victim to fresh air. If victim has stopped breathing, give artificial respiration, preferably by mouth-to-mouth. Get medical attention immediately.

SECTION VI - PHYSICAL DATA

BOILING POINT:	Over 400° F (204° C) at 760 MM Pressure
POUR POINT:	+10° F (-12° C) [ASTM D97-93]
VAPOR PRESSURE:	Less than 1 MM HG Pressure @ 162°F (72° C); NON EXPLOSIVE
SPECIFIC GRAVITY:	0.8877 @ 60°F (15.6°C) [ASTM D1298-85(90)]
SOLUBILITY IN WATER:	NEGLIGIBLE AT ROOM TEMPERATURE
APPEARANCE AND COLOR:	LIGHT AMBER TO CLEAR LIQUID AT ROOM TEMPERATURE
VISCOSITY:	4.15 CST @ 104°F (40°C) [ASTM, D92-90]

SECTION VII - FIRE AND EXPOSION HAZARDS

FLASH POINT/METHOD USED: 360° F (182° C) [ASTM, D445-88]

FLAMMABLE LIMITS IN AIR, % BY VOL. LOWER: NOT APPLICABLE/NON-VOLATILE
FLAMMABLE LIMITS IN AIR, BY VOL. UPPER.: NOT APPLICABLE/NON-VOLATILE

NFPA RATING: NO NFPA RATING

HMIS RATING: **HEALTH (0) FIRE (1) REACTIVITY (0)**

SPECIAL FIRE FIGHTING PROCEDURES & PRECAUTIONS:

(INDIVIDUALS SHOULD PERFORM ONLY THOSE FIRE FIGHTING PROCEDURES FOR WHICH THEY HAVE BEEN TRAINED). USE WATER SPRAY, DRY CHEMICAL, FOAM OR CARBON DIOXIDE. WATER MAY BE INEFFECTIVE, BUT SHOULD BE USED TO KEEP FIRE-EXPOSED CONTAINERS COOL. WATER SPRAY MAY BE USED TO FLUSH SPILLS AWAY FROM FIRE.

USUAL FIRE & EXPLOSION HAZARDS:

OIL SOAKED RAGS CAN CAUSE SPONTANEOUS COMBUSTION IF NOT HANDLED PROPERLY. BEFORE DISPOSAL, WASH RAGS WITH SOAP AND WATER AND DRY IN WELL VENTILATED AREA.

FIRE FIGHTERS SHOULD WEAR SELF-CONTAINED BREATHING APPARATUS IN THE POSITIVE-PRESSURE MODE WITH A FULL FACEPIECE WHEN THERE IS A POSSIBILITY OF EXPOSURE TO SMOKE, FUMES OR HAZARDOUS DECOMPOSITION PRODUCTS (CO_2 AND CO).

SECTION VIII - REACTIVITY

STABILITY:	GENERALLY STABLE
HAZARDOUS POLYMERIZATION:	NONE LIKELY
CONDITIONS & MATERIALS TO AVOID:	AVOID CONTACT WITH STRONG OXIDIZING AGENTS. SOLVENT ACTION DISSOLVES RUBBER MATERIALS, STYROFOAM AND POLYURETHANE
HAZARDOUS DECOMPOSITION PRODUCTS:	COMBUSTION WOULD PRODUCE CARBON MONOXIDE AND CARBON DIOXIDE.

SECTION IX - EMPLOYEE PROTECTION

CONTROL MEASURES:	HANDLE IN THE PRESENCE OF ADEQUATE VENTILATION WHEN USED TO DISSOLVE CRUDE OIL AND SPILLED PETROLEUM.
RESPIRATORY PROTECTION:	RECOMMENDED EXPOSURE LIMITS (i.e. OSHA-PEL AND ACGTH-TLV) HAVE NOT BEEN ESTABLISHED FOR THIS MATERIAL. WHETHER THERE IS A NEED FOR RESPIRATORY PROTECTION UNDER YOU CONDITIONS OF HANDLING OF THIS MATERIAL SHOULD BE EVALUATED BY A QUALIFIED HEALTH SPECIALIST.
PROTECTIVE CLOTHING:	GLOVES RECOMMENDED FOR ANY APPLICATION INVOLVING THE CLEANUP OR DEGREASING OF WASTE OIL.
EYE PROTECTION:	WEAR SAFETY GLASSES PER ANSI STANDARD Z87.1

SECTION X - ENVIRONMENTAL PROTECTION

ENVIRONMENTAL PRECAUTIONS:	AVOID UNCONTROLLED RELEASES OF THIS MATERIAL. WHERE SPILLS ARE POSSIBLE, A COMPREHENSIVE SPILL RESPONSE PLAN SHOULD BE DEVELOPED AND IMPLEMENTED. PREVENT RELEASES TO WATER.
SPILL OR LEAK PRECAUTIONS:	CONTAIN SPILLED MATERIAL AND TRANSFER TO SECURE CONTAINERS. WHERE NECESSARY, COLLECT USING ABSORBENT MEDIA, WASH DOWN AREA WITH DETERGENT. IN THE EVENT OF AN UNCONTROLLED RELEASE OF THIS MATERIAL, THE USER SHOULD DETERMINE IF THE RELEASE IS REPORTABLE UNDER APPLICABLE LAWS AND REGULATIONS. USE DOUBLE CONTAINMENT IF POSSIBLE.
WASTE DISPOSAL:	ALL RECOVERED MATERIAL SHOULD BE PACKAGED, LABELED, TRANSPORTED, AND DISPOSED OR RECLAIMED IN CONFORMANCE WITH APPLICABLE LAWS AND REGULATIONS AND IN CONFORMANCE WITH GOOD ENGINEERING PRACTICES. AVOID LANDFILLING OF LIQUIDS. RECYCLE UNUSED PRODUCT AT REGULAR OIL COLLECTION FACILITY OR BLEND WITH BURNER FUEL.
MARINE TOXICITY:	*MYSIDOPSIS BAHIA* (U.S. EPA 1991) BIOASSAY: LC_{50} = 122 PPM. *MENIDIA BERYLLINA* (U.S. EPA 1990) BIOASSAY: LC_{50}=578 PPM TOXICITY BELIEVED TO BE DUE TO RESTRICTED OXYGEN DIFFUSION ON WATER SURFACE BY FLOATING PRODUCT.
BIODEGRADABILITY:	BIODEGRADES IN SEAWATER WITH A HALF-LIFE OF 4 DAYS. IN EPA STANDARD BIODEGRADATION ASSAY, THE PRODUCT IS COMPLETELY BIODEGRADED TO CARBON DIOXIDE IN 28 DAYS

SECTION XI - REGULATORY CONTROLS

OTHER REGULATORY REQUIREMENTS: LISTED IN TSCA INVENTORY(SOY METHYL ESTERS)

LISTED ON EPA'S NATIONAL CONTINGENCY PLAN (NCP)
SCHEDULE OF PRODUCTS (1997) USED IN OIL SPILL CLEAN UPS

LICENSED IN CALIFORNIA AS A SHORELINE CLEANER FOR USE IN SENSITIVE AQUATIC OR MARINE ECOSYSTEMS DURING OIL SPILL CLEANUPS.

SECTION XII-PRECAUTIONS: STORAGE, HANDLING AND USAGE

NO SPECIAL HEALTH PRECAUTIONS ARE NECESSARY. HOWEVER, CYTOSOL SHOULD BE HANDLED AND TREATED WITH THE SAME ENVIRONMENTAL SAFETY PRECAUTIONS AS ANY SOLVENT. AVOID CONTACT WITH STYROFOAM, POLYURETHANE AND NATURAL RUBBER PRODUCTS - SOLVENT ACTION WILL DISSOLVE THESE MATERIALS. DO NOT EXPOSE TO OLD PAINTED SURFACES, CAULKING, RUBBER OR OTHER POLYMERS NOT SPECIFICALLY DESIGNED TO HANDLE SOLVENTS. IN CASE OF SPILLS, WIPE UP OR VACUUM SPILLED PRODUCT AND IMMEDIATELY [illegible] WATERWAYS OR STORM SEWERS.

The information presented herein is believed to be factual as it has been derived from the works and opinions of persons believed to have qualified experts; however, nothing contained in this information is to be taken as a warranty or representation for which CytoCulture International, Inc. bears legal responsibility. The user should review any recommendations in the specific context of the intended use to determine whether they are appropriate or contact CytoCulture for consultations.

PREPARED BY: [illegible] President & Director of Research DATED: [illegible]

CytoCulture International, Inc.
249 Tewksbury Avenue
Point Richmond, CA 94801
Email: RvW@cytoculture.com

TEL: 510-233-0102
FAX: 510-233-3777
CELL: 561-762-5440

CRUDE OIL CLEANER

MATERIAL SAFETY DATA SHEET

ENVIRONMENTAL 1 Crude Oil Cleaner

SECTION I –IDENTIFICATION OF MATERIAL AND SUPPLIER

PRODUCT NAME: **Environmental 1 Crude Oil Cleaner**

CHEMICAL FAMILY: Organic, natural derived, bio-renewable carbon.

SUPPLIER: **Environmental 1, LLC**
One American Center
3100 West End Avenue, Suite 450
Nashville, Tennessee 37203
United States of America

IN CASE OF EMERGENCY: 1 (866) 366-3353

SECTION II – COMPOSITION / INFORMATION ON INGREDIENTS

Ingredient	CAS #	% by Weight
Trade Secret Formulation Proprietary Blend of Non-Hazardous Chemicals; May be naturally derived. Active ingredient: minimum risk exempt from the requirement of a tolerance	Proprietary	

All ingredients meet criteria of EPA "DfE" (Design for the Environment) program approval. Components listed on www.cleangredients.org. All ingredients plant derived. Hydrotrope property. Anti-static component. Industrial carbon removal property.

SECTION III – HAZARDS IDENTIFICATION

Physical State:	Clear Aqueous solution.
Odor:	Odorless
Emergency Overview:	No emergency medical reactions.
Toxic Fumes or Vapors:	No toxic fumes or vapors, not a respiratory toxicant.
Potential Health Effects:	Possible, slight irritant to eyes or skin.
Carcinogenic Effects:	No carcinogenicity. Listed by IARC, NTP, OSHA or ACGIH.
Routes of Exposure:	Skin and eye contact. Direct spray into eyes, prolonged contact with skin at increased concentrations and skin patch, may cause irritation.

SECTION IV –FIRST AID MEASURES

Eye Contact:	If direct eye contact occurs, rinse with water until clear.
Skin Contact:	If irritation should occur, rinse with water thoroughly, avoid continuous prolonged contact.
Note:	As with all chemicals, Keep out of reach of children. If any symptoms persist consult a physician.

SECTION V – FIRE FIGHTING MEASURES

Flammable Properties:	Non Flammable.
Fire/Explosion Hazards:	Non Combustible or explosive.
Extinguishing Media:	Water, Fog, Dry Powder or Carbon Dioxide.

SECTION VI – ACCIDENTAL RELEASE MEASURES

Personal Safeguards:	Review FIRE FIGHTING MEASURES AND HANDLING sections before proceeding with clean up. Use appropriate PERSONAL PROTECTIVE EQUIPMENT during clean up.
Accidental Release:	**Spills:** Absorb liquid with absorbent material. **Large Spills:** Stop spill at source. Dike area of spill to prevent spreading. Pump liquid into waste containers. Remaining liquid can be absorbed.

SECTION VII – HANDLING AND STORAGE

Handling:	Avoid directly spraying into eyes. Use goggles with power spraying.
Storage:	Store in a dry area.

SECTION VIII – EXPOSURE CONTROLS / PERSONAL PROTECTION

Personal Protection:	**Eye Protection:**	Not routinely required.
	Protective Clothing:	Not routinely required.
	Respirators:	Not routinely required.
Exposure Guidelines:	Use only as directed per label.	
Exposure Limits:	No designated exposure limit.	

SECTION VIX – PHYSICAL AND CHEMICAL PROPERTIES

Physical State:	Aqueous solution
Color:	Clear
Odor:	Odorless
Boiling/Melting Point:	Not Determined
Vapour Pressure:	Not Determined
Specific Gravity:	1.01
Miscibility:	Miscible in water at 20° C
Solubility in Water:	Completely Soluble
pH:	Neutral
Evaporation Rate:	Not Determined
VOC Content:	Less than 0.1%

Foam booster even in high electrolyte solutions, lowers overall density. Acid resistant property, biodegradable, inhibits corrosion and rust. Viscosity builder and detergent on hard surface cleaning. Hydrotrope property. Anti-static component. Industrial carbon removal property. Utilizes rheology.

SECTION X – STABILITY AND REACTIVITY

Chemical Stability: Stable

Incompatibilities: None currently known.

Decomposition: None

Polymerization: Does not occur.

SECTION XI – TOXICOLOGICAL PROPERTIES

Ingredient	Endpoint/Parameter	Value
Environmental 1 Crude Oil	Acute Oral LD_{50} (rat)	> 2,000 mg/kg
	Acute Dermal LD_{50} (rat)	> 2,000 mg/kg
	Acute Inhalation LC_{50} (rat)	> 2.05 mg/L

Environmental 1 Crude Oil Cleaner, in the ready to use solution, was tested using the Environmental Protection Agency (EPA) protocol listed in 40CFR Chapter 1 (7-1-99) Pt. 300 Appendix C, Item 3.0. Revised Standard Dispersant Toxicity Test. The Marine invertebrate species, *Menidia beryllina* were used in the tests. A dilution series of 100 ppm, 200 ppm, 300 ppm, 400 ppm, and 500 ppm was used for both Environmental 1 Crude Oil Cleaner product tests. Test duration using *M. bahia and M. beryllina* was 48 hours and 96 hours respectively.

Testing was completed by Bio-Aquatic Testing, Inc, Carrollton, Texas.

A summary of all the LC-50 values is given below:

Material Tested	Species	LC50 (PPM)	Least to Most Toxic
Environmental 1 Crude Oil Cleaner	*Menidia beryllina*	209.79	1
	Mysidopsis bahia	182.39	2
Reference Toxicant: (Sodium Laurel Sulfate)	*Menidia beryllina*	12.04	
	Mysidopsis bahia	8.19	

National Oil and Hazardous Solutions Contingency Plan

US Environmental Protection Agency notification 8-25-2010: After Environmental 1 provided the technical product data required by the National Oil and Hazardous Substances Pollution Contingency Plan (NCP), 40 CFR Part 300, the "Environmental 1 Crude Oil Cleaner" (aka Environmental 1 washing agent) satisfied the requirements contained in Title 40 of the CFR section 300.915 of the NCP. "Environmental 1 Crude Oil Cleaner" will be listed on the NCP Product Schedule under the Surface Washing Agent category and may be authorized for use by Federal On-Scene Coordinators in accordance with 40 CFR Section 300.910.

Skin Sensitization (Buehler):	Non-Sensitizing
Special Remarks on Toxicity to Animals:	None
Special Remarks on Toxicity to Humans:	Non-toxic at acute exposure at 5,000 mg/kg level.
Environmental Toxicity:	No threat to environmental health.

SECTION XII – ECOLOGICAL INFORMATION

Acute Ecotoxicity:	Not considered an environmental hazard.
Chronic Ecotoxicity:	Not considered an environmental hazard. No long-term residual.
Persistence:	Readily Biodegradable in accordance with OECD 301, GLP compliant standards.
Mobility:	Not Applicable.
Bioaccumulation:	No persistent chemical residues.

SECTION XIII – DISPOSAL CONSIDERATIONS

Disposal Method:	No Federal or State specific regulations for disposal "As Is".

SECTION XIV – TRANSPORT INFORMATION

Hazard Classification:	This product is not hazardous or caustic.
Water (IMO):	No Regulation Required
Air (IATA/ICAO):	No Regulation Required
Ground (DOT)/(TDG Canada):	No Regulation Required

SECTION XV – REGULATORY INFORMATION

Sara 302 (Threshold Planning Quantity):	Emergency Planning Notification: Not Applicable				
Sara 304 (Reportable Quantity):	Emergency Chemical Release Notification: Not Applicable				
Sara 311 Categories:	**Health Effects (Acute):**	None			
	Health Effects (Chronic):	None			
	Fire Hazard:	None			
WHIMIS Status (Canada):	Not a Controlled Product.				
NFPA, NPCA – HMIS RATING:	**Health:**	1	**Flammability:** 0	**Reactivity:**	0

GlobalTox Toxicology International Consultants, Guelph, Ontario Canada

SECTION XVI – OTHER INFORMATION

This information is furnished with out warranty, representation, inducement or license of any kind, except that it is accurate to the best of knowledge of J&J Technology LLC, or obtained from sources believed to be accurate. J&J Technology LLC does not assume any legal responsibility for use or reliance on the same. Customers are encouraged to read the product label.

The results of this MSDS Information is made available with the cooperative input from **GlobalTox Toxicology International Consultants**, Guelph, Ontario Canada, Product **Safety Laboratories**, New Jersey, USA, and **Bio-Aquatic Testing Inc,** Carrollton, Texas.

Environmental 1, LLC
One American Center
3100 West End Avenue, Suite 450
Nashville, TN 37203

EMERGENCY PHONE: 1-866-366-3353

PLUTUS©
ENVIRONMENTAL TECHNOLOGIES, INC.

Material Safety Data Sheet
May be used to comply with OSHA's Hazard Communication Standard, 29 CFR 1910 1200. Standard must be consulted for specific requirements.

U.S. Department of Labor
Occupational Safety and Health Administration
(Non-Mandatory Form)
Form Approved
OMB No. 1218-0072

IDENTITY *(as Used on Label and List)*

E-SAFE© Environmentally-Safe Cleaner

Note: Blank spaces are not permitted. If any item is not applicable or no information is available, the space must be marked to indicate that.

Section I—Manufacturer's Information

Manufacturer's name	Emergency Telephone Number
PLUTUS Environmental Technologies, Inc.	**++1 (865) 453-0060** **++1 (865) 453-0060**
Address *(Number, Street, City, State and ZIP Code)*	Telephone Number for Information
807 Mize Lane	**++1 (865) 453-0060**
Sevierville, Tennessee 37862-3027	Date Prepared **Updated: 01 September 2004**
USA	Signature of Preparer *(optional)*

Section II—Hazardous Ingredients/Identity Information

Hazardous Components (Specific Chemical Identity, Common Name(s))	OSHA PEL	ACGIH TLV	Other Limits Recommended	% (optional)
None; Proprietary blend of surfactants and organic solvents in aqueous solution; Contains 2 ppm Floresin and 2 ppm Orcoacid Orltofast Turq for identification.				

Section III—Physical/Chemical Characteristics

Boiling Point	**H_20 = 100°C**	Specific Gravity (H_20 = 1)	**1.04 to 1.27**
Vapor Pressure (mm Hg)	**N/A**	Melting Point	**N/A**
Vapor Density (AIR = 1)	**N/A**	Evaporation Rate (Butyl Acetate = 1)	**N/A**

Solubility in Water **Infinite**

Appearance and Odor **Clear Green color; Light Citrus odor**

Section IV—Fire and Explosion Hazard Data

Flash Point (Method Used)	Flammable Limits	LEL	UEL
NONE	**N/A**	**N/A**	**N/A**

Extinguishing Media **N/A**

Special Fire Fighting Procedures **N/A**

Unusual Fire and Explosion Hazards **None Known**

(Reproduce locally) OSHA 174 Sept. 1985

Section V—Reactivity Data

Stability	Unstable	Conditions to Avoid: None known, unless water is evaporated; if all aqueous phase is
	Stable: X	evaporated, components will completely volatize.

Incompatibility *(Materials to Avoid)*: Hydrocarbon-based substances; aluminum; silicone

Hazardous Decomposition or Byproducts: None known

Hazardous Polymerization	May Occur	Conditions to Avoid: N/A
	Will Not Occur: X	

Section VI—Health Hazard Data

Route(s) of Entry: NO Inhalation? NO Skin? NO Ingestion? May cause diarrhea

Health Hazards *(Acute and Chronic)*: May cause diarrhea if volume ingested

Carcinogenicity: NO NTP? NO IARC Monographs? NO OSHA Regulated? NO

Signs and Symptoms of Exposure: Hands may redden if immersed for several for several hours

Medical Conditions Generally Aggravated by Exposure: None Known.

Emergency and First Aid Procedures: If ingested, drink quantities of fresh water; DO NOT INDUCE VOMITING. Flush eyes with water or saline solution. Call physician if irritation persists.

Section VII—Precautions for Safe Handling and Use

Steps to Be Taken in Case Material Is Released or Spilled: Mop up or use absorbent material; dispose in trash. Rinse surface thoroughly and apply local safety/spill clean-up measures as needed or required.

Waste Disposal Method: May be safely poured down drain.

Precautions to Be Taken in Handling and Storing: None known.

Other Precautions: Personal Protective Equipment (PPE) is not required. Safety goggles are suggested when using this product or any other chemical product.

Section VIII—Control Measures

Respiratory Protection *(Specify Type)*: N/A; Contains no VOCs.

Ventilation	Local Exhaust: None needed.	Special: None needed.	
	Mechanical *(General)*: N/A	Other: None needed.	

Protective Gloves: Not required. Eye Protection: Suggested with use.

Other Protective Clothing or Equipment: As needed or required by work site policies and procedures.

Work/Hygienic Practices: Avoid excessive exposure.

Gold Crew SW®

an EPA NCP Listed Surface Washing Agent

Gold Crew SW is a multi purpose spill response agent that is used for effectively and economically mitigating hazards and environmental impacts from a wide range of hydrocarbon based materials and industrial paints and coatings.

Gold Crew SW offers these advanced features
Vapor Suppression * Hydrocarbon Mitigation * Water Based * Biodegradable * Concentrated

Local Technical support and international networking ensures your projects success.

www.goldcrew.net

Gold Crew SW is on the U.S. Environmental Protection Agency's NCP Product Schedule. This listing does NOT mean that the EPA approves, recommends, licenses, certifies or authorizes the use of Gold Crew on an oil discharge. This listing means only that dada have been submitted to EPA as required by subpart J of the National Contingency Plan, 309.915.

ORANGE-SOL
Blending & Packaging
incorporated

MATERIAL SAFETY DATA SHEET

ORANGE-SOL™

Clean-Away™
APC Super Concentrate

™ Trademark of the ORANGE-SOL Group of Companies, Ltd.

Section 1
Product & Company Identifications

Product Name: Clean-Away™ APC Super Concentrate

Product Use: Removal of food spills, grease and grime.

Manufacturer: ORANGE-SOL Blending & Packaging, Inc.
1400 N. Fiesta Blvd., Bldg. 100
Gilbert, AZ 85233-1023

For Information & Emergencies: (480) 497-8822 (7 am-5pm, Mon-Fri MST) www.orange-sol.com

Preparation Date: 14 May 1999

Revision Date: 20 May 2009

MSDS #: 50018-284

Section 2
Information on Ingredients

Product Mixture: No hazardous ingredients as per OSHA, 29CFR 1910.1200.

Components: This section is proprietary.

Section 3
Hazardous Identification

Emergency Overview: Avoid inhalation of mist and contact with eyes.

Primary Routes of Contact: Ingestion, inhalation, and absorption.

Physical Hazard: None established.

Health Hazard

Eye: May cause irritation.

Skin: Repeated or prolonged exposure may cause dermatitis in sensitive individuals.

Ingestion: May cause gastric disturbances such as diarrhea.

Vapor Inhalation: Avoid mists, which may irritate mucous membranes.

Carcinogenicity Listings: **NTP:** None. **IARC:** None.

OSHA: None. **ACGIH:** None.

Signs and Symptoms of Overexposure: Red, dry skin at point of contact.

Medical Conditions Aggravated by Exposure: Dermatitis may become aggravated by sensitive individuals.

Section 4
First Aid Procedures

Eye: Remove contact lenses, flush with water for at least 15 minutes while lifting eyelids. If irritation develops and persists, contact a physician.

Skin: Remove effected clothing. Wash skin thoroughly with soap and water. If irritation develops and persists, contact a physician.

Ingestion: If swallowed, do not induce vomiting. May cause chemical pneumonia if aspirated into lungs.

Inhalation: Move to fresh air. If irritation develops and persists, contact a physician.

Section 5
Fire & Explosion Hazard

Flash Point and Method: None.

Flammability: Non Flammable

Explosion Data: **Sensitivity to impact:** None. **Sensitivity to static charge:** None.

Combustion Products: As with any organic material, combustion will produce carbon dioxide an/or carbon monoxide.

Extinguishing Media: Water fog, carbon dioxide, dry chemical, foam.

Unusual Fire and Explosion Hazard: None.

Special Firefighting Precautions: Do not use streams of water; may spread burning liquid.

Firefighting Equipment: Use self-contained breathing apparatus in any enclosed area.

Section 6
Accidental Release Measures

Small Spills: Absorb with suitable material. Dispose in an appropriate waste container.

Large Spills: Dike with soil, and or other suitable materials avoiding the use of sawdust. Recover usable product, rinse area clean.

Personal Precautions: No special requirements.

Environmental Precautions: No special requirements known.

Section 7
Handling & Storage

Safe Handling and Hygienic Practices: Avoid prolonged skin contact. Wash after using.

Storage Requirements: Store in tightly closed, original container above freezing and below 210°F.

Section 8
Exposure Controls

Engineering Controls: No special requirements.

Personal Protection

Ventilation: No Special requirements.

Respiratory: Avoid breathing mist.

Eye Protection: Eye protection based on splash potential.

Clothing: Gloves recommended for sensitive individuals.

Exposure Limit Guidelines: None established.

Section 9
Physical & Chemical Properties

Appearance and Odor: A light amber color with a light soapy odor.

Specific Gravity: 1.024, 8.55 lbs/US gallon.

Vapor Density: (Air=1), >1. (Estimated)

Vapor Pressure: Not Determined.

Evaporation Rate: (BuAc=1) <1 (Established).

pH of Concentrate: 9 - 9.5

Solubility in Water: 100%.

Percent Volatile by Volume: 86% (Estimated).

Section 10
Stability & Reactivity

Stability: Stabile.

Conditions to Avoid: Avoid materials that react violently with water.

Hazardous Decomposition: None expected under normal conditions.

Hazardous Polymerization: Should not occur.

Section 11
Toxicity Information

Toxicity: None known.

Section 12
Disposal Considerations

Biodegradability: Biodegradable.

RCRA Classification: This product has been evaluated for RCRA characteristics and does not meet the criteria for a hazardous waste, if discarded in its purchased form.

Special Instructions: No special requirements.

Section 13
Transportation Information

DOT Labeling: Not required.

Proper Shipping Name: Not required.

Hazard Class: Not required.

Identification Number: Not required.

Section 14
Regulatory Information

CERCLA, State and Local Planning (Reportable Quantities): Not required.

OSHA Compliance: This MSDS prepared in accordance with 29CFR 1910.1200 and ANSI Z400.1 standard.

SARA Title III Superfund: The product in its purchased form is not regulated under the SARA "Hazard Categories" under Section 311 and 312 of the Superfund Amendment and the Reauthorization Act of 1986 (SARA Title III).

State Right-to-Know Compliance: None

TSCA: Although components of this product find listing under the Toxic Substances Act (TSCA), this blended product requires no import or export declaration.

Volatile Organic Compound (VOC) Content: This product complies with all VOC requirements in all 50 states.

Special Instructions: No special requirements.

Section 15
Other Information

Hazard: (Based on HMIS Standard), Health: 0 Flammability: 0 Reactivity: 0

Hazard Index: Slight: 0, Moderate: 1, Serious: 2, Severe: 3, Extreme: 4

We believe the information contained herein is accurate and current as of the date of this Material Safety Data Sheet. Nevertheless, the user must evaluate and determine whether the conditions for use and application of the product, including proper disposal thereof, are appropriate, safe, and legal.

ORANGE-SOL
Blending & Packaging
incorporated

MATERIAL SAFETY DATA SHEET

De-Solv-it®

Industrial Formula W/O Lanolin

™ Trademark of the ORANGE-SOL Group of Companies, Ltd.

Section 1
Product & Company Identifications

Product Name: De-Solv-it® Industrial Formula W/O Lanolin

Product Use: Removal of crude oil, tar, mousse, processed petroleum oils, asphalts, adhesives, grease, wax, etc.

Manufacturer: ORANGE-SOL Blending & Packaging, Inc.
1400 N. Fiesta Blvd., Bldg. 100
Gilbert, AZ 85233-1023

For Information & Emergencies: (480) 497-8822 (8 am-5pm, Mon-Fri MST) www.orange-sol.com

Preparation Date: 3 Apr 1992

Revision Date: 2 Jun 2010

MSDS #: 50649-280

Section 2
Information on Ingredients

Product Mixture: No hazardous ingredients as per OSHA, 29CFR 1910.1200.

Components: This section is proprietary.

Section 3
Hazardous Identification

Emergency Overview: Avoid inhalation of mist and contact with eyes.

Primary Routes of Contact: Ingestion, inhalation, and absorption.

Physical Hazard: Combustible mixture.

Health Hazard

Eye: May cause irritation.

Skin: Repeated or prolonged exposure may cause dermatitis in sensitive individuals.

Ingestion: May cause gastric disturbances such as diarrhea.

Vapor Inhalation: Avoid mists, which may irritate mucous membranes.

Carcinogenicity Listings: **NTP:** None. **IARC:** None.

OSHA: None. **ACGIH:** None.

Signs and Symptoms of Overexposure: Red, dry skin at point of contact.

Medical Conditions Aggravated by Exposure: Dermatitis may become aggravated by sensitive individuals.

Section 4
First Aid Procedures

Eye: Remove contact lenses, flush with water for at least 15 minutes while lifting eyelids. If irritation develops and persists, contact a physician.

Skin: Remove effected clothing. Wash skin thoroughly with soap and water. If irritation develops and persists, contact a physician.

Ingestion: If swallowed, do not induce vomiting. May cause chemical pneumonia if aspirated into lungs.

Inhalation: Move to fresh air. If irritation develops and persists, contact a physician.

Section 5
Fire & Explosion Hazard

Flash Point and Method:145°F (63°C), PMCC, ASTM D-93.

Flammability: Combustible

Explosion Data: **Sensitivity to impact:** None. **Sensitivity to static charge:** None.

Combustion Products: As with any organic material, combustion will produce carbon dioxide an/or carbon monoxide.

Extinguishing Media: Water fog, carbon dioxide, dry chemical, foam.

Unusual Fire and Explosion Hazard: None.

Special Firefighting Precautions: Do not use streams of water; may spread burning liquid.

Firefighting Equipment: Use self-contained breathing apparatus in any enclosed area.

Section 6
Accidental Release Measures

Small Spills: Absorb with suitable material. Dispose in an appropriate waste container.

Large Spills: Dike with soil, and or other suitable materials avoiding the use of sawdust. Recover usable product, rinse area clean.

Personal Precautions: No special requirements.

Environmental Precautions: No special requirements known.

Section 7
Handling & Storage

Safe Handling and Hygienic Practices: Avoid prolonged skin contact. Wash after using.

Storage Requirements: Store in tightly closed, original container away from flame or other ignition source between 0°F to 120°F.

Section 8
Exposure Controls

Engineering Controls: No special requirements.

Personal Protection

Ventilation: No Special requirements.

Respiratory: Avoid breathing mist.

Eye Protection: Goggles recommended where splash potential.

Clothing: Gloves recommended for sensitive individuals.

Exposure Limit Guidelines: None established.

Section 9
Physical & Chemical Properties

Appearance and Odor: Clear orange color with a citrus odor.

Specific Gravity: .8173, 6.8204 lbs/US gallon.

Vapor Density: (Air=1), 4.5. (Estimated)

Vapor Pressure: <0.0 mm of Hg @ 20°C, <0.000 psi @ 68°F.

Evaporation Rate: (BuAc=1) 0.06.

pH of Concentrate: None.

Solubility in Water: Not Soluble.

Percent Volatile by Volume: 99%.

Section 10
Stability & Reactivity

Stability: Stabile.

Conditions to Avoid: Avoid contact with oxidizing agents and acids.

Hazardous Decomposition: None expected under normal conditions.

Hazardous Polymerization: Should not occur.

Section 11
Toxicity Information

Toxicity: None known.

Section 12
Ecological Information

Biodegradability: Biodegradable.

Other: Liquid is not expected to have acute toxicity to aquatic organisms.

Section 13
Disposal Considerations

Biodegradability: Biodegradable.

RCRA Classification: This product has been evaluated for RCRA characteristics and does not meet the criteria for a hazardous waste, if discarded in its purchased form.

Special Instructions: No special requirements.

Section 14
Transportation Information

U.S. Department Of Transportation (DOT)
Shipping Description: Not Regulated
Note: Material is unregulated unless shipped by land in a packaging having a capacity of 3,500 gallons or more. Then provisions of 49 CFR, Part 130 apply.

International Maritime Dangerous Goods (IMDG)
Shipping Description: Not regulated. Flash point is above 61°C.

International Civil Aviation Org. / International Air Transport Assoc. (ICAO/IATA)
UN/ID#: Not Regulated. Flash point is above 61°C.

Section 15
Regulatory Information

CERCLA, State and Local Planning (Reportable Quantities): Not required.

OSHA Compliance: This MSDS prepared in accordance with 29CFR 1910.1200 and ANSI Z400.1 standard.

SARA Title III Superfund: The product in its purchased form is not regulated under the SARA "Hazard Categories" under Section 311 and 312 of the Superfund Amendment and the Reauthorization Act of 1986 (SARA Title III).

State Right-to-Know Compliance: Not required.

TSCA: Although components of this product find listing under the Toxic Substances Act (TSCA), this blended product requires no import or export declaration.

Volatile Organic Compound (VOC) Content: This product complies with all VOC requirements in all 50 states.

Special Instructions: No special requirements.

Section 16
Other Information

Hazard: (Based on HMIS Standard), Health: 0 Flammability: 2 Reactivity: 0

Hazard Index: Minimal: 0, Slight: 1, Moderate: 2, High: 3, Extreme: 4

We believe the information contained herein is accurate and current as of the date of this Material Safety Data Sheet. Nevertheless, the user must evaluate and determine whether the conditions for use and application of the product, including proper disposal thereof, are appropriate, safe, and legal. thereof, are appropriate, safe, and legal.
thereof, are appropriate, safe, and legal.

NALE-IT™

MATERIAL SAFETY DATA SHEET

MSDS #72559
Emergency Telephone Numbers: (580) 788-2187
Revised: 04/14/98
SPL CONTROL L.L.C. (580) 788-2187

CHEMTREC (24 HOURS): (800) 424-9300

This document is prepared pursuant to the OSHA Hazardous Communications Standard (29 CFR Section 1910.1200). Also, other substance not deemed "HAZARDOUS" per this MSDS may be listed.

SECTION I. MANUFACTURED BY:

SPL CONTROL L.L.C.
P.O. BOX 627
ELMORE CITY, OK 73433
Tel: (580) 788-2187

SECTION II. MATERIAL IDENTIFICATION:

Trade Name:	NALE-IT (MICROSOLV)
Synonyms:	Cleaning Compound
Chemical Formula:	Proprietary

SECTION III. PHYSICAL & CHEMICAL DATA:

Boiling Point:	212°F	Freezing Point:	32°F (Store above 50°F)
Specific Gravity:	1.02	Vapor Pressure(m Hg):	N/A
Vapor Density (Air = 1):	N/A	Solubility in H2O:	Soluble
Appearance:	Clear green liquid	Odor:	Bland

SECTION IV. REACTIVITY:

Stability:	Stable under normal conditions
Incompatibility:	Strong acids, bases
Decomposition Products:	None
Hazardous Polymerization:	Will not occur

SECTION V. FIRE & EXPLOSION DATA:

Flash Point:	No flash at boiling point
Extinguishing Media:	Non-flammable
Special Fire Fighting Procedures:	None
Unusual Fire Hazards:	N/A
pH:	6.8-7.2

SECTION VI. EMERGENCY & FIRST AID DATA:

Inhalation:	Move to well ventilated area; if breathing difficulties persist after 15 minutes seek medical assistance.
Eye Contact:	Wash eye thoroughly for 15 minutes; including upper and lower lids. Seek medical assistance.
Skin Contact:	Wash affected area with soap & water for 15 minutes; if irritation persists seek medical assistance.
Ingestion:	If conscious, administer 2 glasses of water. Seek medical assistance. Do not induce vomiting unless directed.

SECTION VII. HEALTH HAZARDS DATA:

Acute:	May irritate eyes, respiratory tract, skin.
Chronic:	Prolonged contact with skin may result in dryness due to removal of skin oil.

SECTION VIII. SPILL & DISPOSAL DATA:

Accidental Spill Procedures:	Absorb in inert material & place in DOT approved containers for disposal in accordance with local, state & federal regulations. Larger spills may be collected and repackaged.
Handling & Storage:	Keep tightly closed, store cool, dry place.

SECTION IX. SPECIAL PROTECTION DATA:

Respiratory Protection:	Respirator in confined areas.
Ventilation:	Recommended
Protective Gloves:	Rubber
Exhaust:	Mechanical/local
Eye Protection:	Goggles
Other Protection:	As required to avoid skin contact

SECTION X. TRANSPORT INFORMATION:

The following data may not apply to all shipping situations. Consult 49 CFR mode-specific/quantity-specific shipping data.

DOT Proper Shipping Name:	Not regulated
DOT Hazard Class/Division:	Not hazardous
DOT Identification No.:	N/A
DOT Packaging Group:	N/A
Type Label(s) Required:	None*

*For specific Ltd. Qty. Requirement, see DOT regulation 49 CFR.

SECTION XI. DISCLAIMERS:

The information contained herein is provided in good faith and is believed to be correct as of the date hereof. However, SPL CONTROL L.L.C. and it's owner(s) make no representation as to the comprehensiveness or accuracy of the information. It is expected that individuals receiving the information will exercise their independent judgment in determining its appropriateness for a particular purpose. Accordingly, SPL CONTROL L.L.C. will not be responsible for damages of any kind resulting from the use of or reliance upon such information.

NO REPRESENTATIONS OR WARRANTIES, EITHER EXPRESS OR IMPLIED, OF MERCHANTABILITY, FITNESS FOR A PARTICULAR PURPOSE OR OF ANY OTHER NATURE ARE MADE HEREUNDER WITH RESPECT TO THE INFORMATION SET FORTH HEREIN OR TO THE PRODUCT TO WHICH THE INFORMATION REFERS.

ALABASTER CORPORATION

6921 Olson, Pasadena, TX. 77505
281-487-5482 or 1-800-609-2728
www.alabastercorp.com

MATERIAL SAFETY DATA SHEET

1 CHEMICAL PRODUCT & COMPANY IDENTIFICATION

Trade Name	Petro Clean
Manufacturer	Alabaster Corporation 6921 Olson Pasadena, TX 77505
Telephone Numbers	
24 Hour Emergency Assistance	800-609-2728
General Assistance	281-487-5482
Product Class	Surface Cleaning Agent, Liquid
Product Number	Petro Clean

2 COMPOSITION/INFORMATION ON INGREDIENTS

Hazardous Components	CAS Number	OSHA PEL	ACGIH TLV

NONE. This product does not contain any ingredients covered by the provisions of 29 CFR 1910.1200. All ingredients are organic and completely biodegradable. Ingredients not precisely identified are proprietary or non-hazardous. The liquid material is a water-based proprietary mixture of emulsifiers, non ionic surfactant, and in some formulations naturally occurring micro- organisms, which are non-pathogenic to humans, livestock, or agriculture.

The criteria for listing components in the composition section are as follows: Carcinogens are listed when present at 0.1% or greater; components which are otherwise hazardous according to OSHA are listed when present at 1.0% or greater. This is not intended to be complete compositional disclosure.

3 HAZARDS IDENTIFICATION

Emergency Overview

Caution

May cause irritation to the eyes, skin, respiratory, and digestive system.

Health Effects: Eyes

Eye irritation develops immediately with contact and may cause mild irritation experienced as discomfort or pain, excess blinking and tear production, blurred vision, and redness.

Health Effects: Skin

Contact may cause slight irritation on sensitive skin as well as drying out and chapping.

Health Effects: Inhalation

Inhalation of high concentration of vapors may upset stomach and cause slight irritation of the respiratory tract.

Health effects: Ingestion

Ingestion may produce gastrointestinal disturbances including irritation, nausea and vomiting.

4 FIRST AID MEASURES

Eyes

Immediately flush eyes with water for at least 15 minutes while holding eyelids open. If irritation persists get medical attention.

Skin

For skin contact flush with large amounts of water while removing contaminated clothing and shoes. If irritation persists get medical attention.

Inhalation

If symptoms are experienced remove to fresh air. If symptoms persist get medical attention. If the affected person is not breathing apply artificial respiration. If breathing is difficult, give oxygen. Seek medical attention.

Ingestion

If swallowed, do not induce vomiting, get immediate medical attention.

5 FIRE FIGHTING MEASURES

Flash Point:	None
Extinguishing Media:	N/A
Decomposition Products:	Oxides of carbon
UEL:	N/A
LEL:	N/A

Unusual fire and explosion hazards

Containers may explode from internal pressure if confined in fire. Cool with water.

Fire fighting equipment

Fire fighters and others exposed to products of combustion should wear self-contained breathing apparatus and full protective clothing.

6 ACCIDENTAL RELEASE MEASURES

SPILL AND LEAK PROCEDURES

Contain large spills with dikes and transfer material to appropriate containers for reclamation or disposal. Absorb remaining material or small spills with an inert material and dispose of in accordance with applicable regulations.

7 HANDLING AND STORAGE

HANDLING PROCEDURES

Handle in accordance with good industrial hygiene and safety practices. These practices include avoiding unnecessary exposure and prompt removal of material from eyes, skin and clothing.

STORAGE PROCEDURES

Store away from acids and oxidizers.

PRECAUTIONARY MEASURES

Use with adequate ventilation. Do not breathe vapors. Do not breathe spray mist. Do not get in eyes, on skin or clothing. Wash thoroughly after handling.

8 EXPOSURE CONTROLS

General Considerations

Consider the potential hazards of this material, applicable exposure limits, job activities and work place conditions when designing engineering controls and selecting personal protective equipment.

Personal Protective Equipment: Eyes/Face

Wear safety glasses or chemical goggles (if splashing is possible).

Personal Protective Equipment: Skin

Wear suitable protective clothing. Use impervious gloves and boots.

Personal Protective Equipment: Respiratory

Use NIOSH approved vapor respirator if exposure is unknown or exceeds permissible limits. Consult the manufacturer to determine appropriate type of equipment for a given application.

Ventilation

Provide natural or mechanical ventilation to control exposure levels below airborne exposure limits (see section 2). If practical, use local mechanical exhaust ventilation at sources of air contamination such as open process equipment. Consult NFPA Standard 91 for design of exhaust system.

Personal Protective Equipment: General

Eye wash fountain and emergency showers are recommended.

9 PHYSICAL AND CHEMICAL PROPERTIES

Appearance/Odor	Clear golden liquid with medium viscosity and slight detergent smell
Flash Point	None
Specific Gravity	1.02
Vapor Pressure	Same as water
Vapor Density (Air = 1)	Same as water
Evaporation Rater (water = 1)	1
Boiling Point	212°F
Solubility in water	Complete
pH	7.0 – 8.0

10 STABILITY AND REACTIVITY

Chemical Stability

Stable

Hazardous Polymerization

Will not occur

Incompatibility

Strong acids, oxidizers or oxidizing materials

Conditions to avoid

None known

11 TOXICOLOGICAL INFORMATION

Carcinogenicity

None of the components have been identified as carcinogen by NTP, IARC or OSHA.

12 ECOLOGICAL INFORMATION

No data available for this product.

13 DISPOSAL CONSIDERATIONS

Follow all Federal and State Regulations

14 TRANSPORTATION INFORMATION

The data provided in this section is for information only. The description shown may not apply to all shipping situations. Consult 49CFR, or appropriate regulations to properly classify your shipment for transportation.

Proper Shipping Name: Non-hazardous cleaning compound, liquid, non-regulated by 49CFR.

Reportable Quantity:	None
Hazard Class and Label:	None
UN Number:	None
NA Number:	None
ERG:	None

15 REGULATORY INFORMATION

TSCA Status

All ingredients in this product are listed or excluded from listing on the TSCA inventory.

SARA TITLE III

313 Reportable Ingredients: None

CERCLA Reportable Quantity:

There is no calculable Reportable Quantity (RQ) for this product.

16 ADDITIONAL INFORMATION

Revision Statement

Changes have been made throughout this Material Safety Data Sheet. Please read the entire document. Supercedes MSDS dated January 31, 2004.

DISCLAIMER:

Although the information and recommendations set forth herein (hereinafter "Information) are presented in good faith and believed to be correct as of the date hereof, the Company makes no representations as to the completeness or accuracy thereof. Information is supplied upon the condition that the persons receiving this MSDS will make their own determination as to its suitability for their intended purposes prior to use. Since the product is within the exclusive control of the user, it is the user's obligation to determine the conditions of safe use of this product. Such conditions should comply with all Federal Regulations concerning the Product. NO REPRESENTATIONS OF WARRANTIES, EITHER EXPRESS OR IMPLIED, OR MERCHANTABILITY, FITTNESS FOR A PARTICULAR PURPOSE OR OF ANY OTHER NATURE ARE MADE HEREUNDER WITH RESPECT TO INFORMATION OR THE PRODUCT TO WHICH INFORMATION REFERS.

HAZARD RATINGS

	HMIS
Health	1
Flammability	0
Reactivity	0
PPE	X

	NFPA
Health	1
Flammability	0
Reactivity	0
Other	None

EXIMCO INTERNATIONAL, INC.

5250 Gulfton
Suite #2-B
Houston, TX 77081

Tel: (713) 432-7899
eximco@eximco.net
Fax: (713) 432-7898

PROCEDURE to MIX and APPLY PROCLEANS TREATMENT SOLUTION

NOTE: This is a concentrated solution and is to be diluted with freshwater or saltwater prior to application.

As a rule-of-thumb, pre-mix one part of PROCLEANS (PCR) concentrate with 20 parts of water (20:1 mixing ration). Remember that this is only a rule of thumb. Depending on site conditions and the contamination being treated, a higher or lower mixing ration may give more favorable results and promote more economical use of the PCR.

Do not meter concentrated PCR into the water stream of pressure washer. PCR needs to be blended into the water prior to application.

If practical, use a heated pressure washer. Warmth will enhance the cleaning action and may add to bio-remedial action.

Depending on the surface being cleaned, brushing or stirring the PCR treatment solution into/onto the contaminated area may enhance cleaning action.

Rev1: 08Oct2010

Proven International, Inc.

Product Summary of ProCleans
PCR-107, an Oil Spill Bioremediation Compound

For Oil Spill Clean-Up; Machinery, Tank, and Pipeline Washing; Vapor Suppression.

ProCleans PCR-107 (PCR) is a concentrated liquid chemical that is most efficient for cleaning-up oil spills wherever they occur. Onboard ship, such as engine rooms, bilges, and fuel transferring points on deck; Fuel Terminals, at loading racks, leaking valves, contaminated soil, machinery, machinery spaces, and oily-water separators. It is also most effective and fast acting when used to degas and wash empty fuel storage tanks and pipelines.

PCR has two advantages not found in any other product advertised for these uses. It works very quickly, and it adds no hazardous components while converting contaminated media to a non-hazardous state.

- Degassing tanks takes only a few hours.
- Washing tanks and converting sludge to inert non-hazardous material in 24 to 48 hours.
- Treating spot spillage of petroleum, and machinery wash-downs, with a hand held sprayer produces immediate results and the wash water runoff is already biodegrading into non-hazardous media.
- Poured into a ship's bilge it remediates oily water and quickly biodegrades the oil and eliminates any surface sheen, and odors. Slow circulating the bilges with a pump will make this process faster and more efficient. And if possible to aerate the bilge with low pressure air flow will further improve the process. To avoid excessive foaming circulate slowly and use low air pressure.

When using PCR as a Wash, the use of a heated pressure washer will always provide faster and more complete results.

PCR is a concentrated water soluble blend of biodegradable compounds consisting of non-toxic, non-flammable, surfactants. When diluted on-site with water and put in contact with petroleum products, PCR converts the molecular chain of hydrocarbon molecules into minute particles that become a food source for indigenous microbes. It also furnishes additional nutrients to speed the action of the indigenous microbes, and multiplies the number of microbial colonies. This establishes a fast working chemical reaction, and TPH levels can be reduced by as much as 97% in 24 to 48 hours.

Be aware that treatment with PCR may leave hard smooth surfaces feeling oily (soapy). This is due to the surfactant characteristics of the chemical; the surface is not oily. To remove the soapy feeling, rinse the surface with plain water.

Important Characteristics and Credentials of PCR-107:

- Very fast acting, per EPA 418.1 and TX-1005 TPH testing.
- Non-toxic and environmentally friendly to the most sensitive ecosystems, per EPA LC50.
- Leaves no volatile or semi-volatile organics, per EPA 8260B and 8270C.
- It will not cause chronic toxicity, Conforms to ASTM D-4236
- It is a non-chlorinated compound.
- It contains no ozone depleting solvents.
- One hundred percent biodegradable.
- It will not harm finished surfaces.

Distributed by:
Eximco International, Inc.
5250 Gulfton, #2-B
Houston, TX 77081
Tel: 713-432-7899
Fax: 713-432-7898
email: eximco@eximco.net

Case History: Asphaltic Crude Oil Pits, Amazon Basin

Hardened Asphaltic Crude

Liquefied Asphaltic Crude, Drained

July 17, 1995:

A Project was undertaken to remediate a number of oil field pit sites that had been dormant in Ecuador's Amazon basin for over two decades.

A pit, containing tremendous quantities of fallen trees, vegetation and debris mixed with a hardened asphaltic crude oil cap and rainwater was the first phase of the job. The pit also contained 300 cubic meters of sludge that was highly contaminated with degraded crude oil, having the consistency of grease.

ProClean SOL-205 biodegradable petroleum solvent was first sprayed over the hardened asphaltic crude oil cap and allowed to penetrate over a 24 hour period. Once the hardened cap was liquefied, the fallen trees and larger debris were removed, reduced in size with chain saws, and stacked in a lined containment area to avoid further contamination.

The liquefied crude was pumped to a portable tank for screening of smaller debris, where it was stored until off-site transportation was available.

After removing the liquefied crude oil, rainwater, and debris from the pit, a track hoe was used to pull the crude contaminated berm into the pit. The berm material was thoroughly mixed with the sludge, and the reduced debris was placed back into the pit and mixed in with the contaminated material in preparation for a treatment of ProClean PCR-107 petroleum contamination remedy.

The hydrocarbon contaminated mixture was then grid sampled and tested for TPH (Total Petroleum Hydrocarbons) level by lab personnel at Escuela Politecnica Nacional, using U. S. EPA Method 418.1. Results were in excess of 56,000 ppm.

Then ProClean PCR-107, a synergistic blend of synthetic surfactants and nutrients similar to those found naturally in soils, was mixed with 10 parts water and sprayed over the hydrocarbon contaminated mixture of sludge, berm material, and reduced debris at ambient temperature (92 degrees Fahrenheit). A mixture of 1.83 gallons of PCR-107 per cubic meter of contaminated material was used.

A track hoe was used to thoroughly mix the PCR-107 solution into the contaminated material, eventually creating a slurry in the pit. Samples were collected and tested during the mixing process and at the end of 6 hours. TPH results were reported as follows:

16,940 ppm in 30 minutes
15,160 ppm in 1 hour
9,256 ppm in 2 hours
6,210 ppm in 4 hours, and
2,500 ppm in 6 hours.

Pit closure criteria called for reducing TPH levels to below 5,000 ppm.

Clean dirt from an adjacent area was added to help stabilize the treated slurry material, and the pit was left open to dry.

August 4, 1995:

18 days after start of remediation samples of treated sludge from this pit were again collected and analyzed by lab personnel from Escuela Politecnica Nacional in Quito, Ecuador. Test results, using EPA Method 418.1 indicated that the TPH level had dropped to 1,516 ppm and without further agitation or treatment of the sludge. Background TPH levels in an adjacent banana grove were reported to be in excess of 1,000 ppm.

November 3, 1995:

108 days after start of remediation, a site visit revealed that a farmer had claimed the restored pit site and planted corn. The new corn stalks measured 12 to 14 inches in height and appeared healthy. There were no visible signs of hydrocarbons on the site.

Corn planted 4 weeks after completion of remediation

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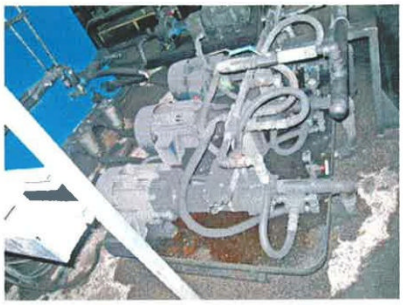
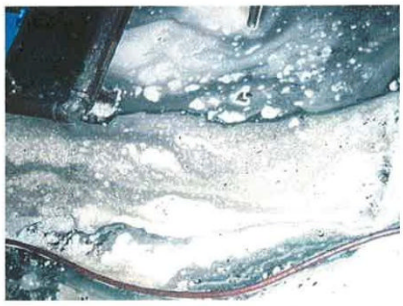
Eximco International, Inc.



High Pressure Pump Station to be Cleaned.

Washing with PROCLEANS Machinery Wash, one part PROCLEANS mixed with 15 parts water.



Oil in the runoff water is being dispersed and emulsfied by the PROCLEANS Wash Solution.

Downstream the oil in the runoff water is already being biodegraded into non-hazardous components.

Pump Station cleaned in 20 minutes. No hazardous components have been added, and the drain system and oily water seperator are also being scrubbed by the action of PROCLEANS cleaning.

CASE HISTORY – Stewart & Stevenson HEMMETT/FMTV Project
Killeen, Texas; November, 2005

In 2005 Proven International was invited by Stewart & Stevenson to see if we could assist them in eradicating their oil and grease discharge from the washing operations at their facility in Killeen, Texas

Stewart & Stevenson had been assigned government contracts by the U.S. Army to refurbish their military vehicles (HEMMETT & FMTV) that were being returned from Iraq and Afghanistan. Upon the completion of the refurbishing task the vehicles had to be washed and readied for shipment back overseas. They had established a wash area for this purpose but the operation was having some unforeseen problems.

Proven suggested that Stewart & Stevenson use ProCleans PCR-107 Oil Clean-Up Compound in the heated pressure washer that was being used to wash down the trucks. Using PCR along with the heat, to breakdown the hydrocarbons and make them more accessible as a food source for the indigenous microbes in the wash water would cure the problem.

The runoff wash water was laden with grease and oil that created a hydrocarbon contamination. With an inspection coming up by the USEPA and the TCEQ for the state of Texas, this would create an unacceptable situation. So Proven laid out a plan to capture the runoff in a 1,000 gallon poly tank and with the aid of a two inch discharge pump, circulated the media for 20 to 30 minutes and then it was discharged to the ground drainage ditch. This process was repeated daily and became a standard operating procedure.

<u>CONCLUSION</u> –

After-Treatment Samples were collected to check the TPH (Total Petroleum Hydrocarbons) levels. The analysis showed that the TPH levels were less than 1,000 ppm, while TECQ regulations call for less than 2,000 ppm prior to discharge. The Prior-to-Treatment TPH level was in excess of 35,000 ppm. This showed Stewart & Stevenson that with PCR-107 along with some mechanical moving of the wash water could keep them in compliance while maintaining a safe and environmentally friendly work environment.

As a by-product of the bioremediation of the wash water, the foul odor that was present in the untreated wash water completely disappeared.

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SAFE CARE®

Industrial Cleaners, Solvents & Specialty Products

SAFE CARE® SC-1000 Aqueous Cleaner Concentrate

DESCRIPTION: ***SC-1000 Aqueous Cleaner Concentrate*** is our most versatile and powerful cleaner used in a variety of industrial and commercial applications. Comprised of non-ionic surfactants and seed ester alcohols, ***SC-1000***™ is a colloidal solution that creates a unique hydrocarbon release agent that can tolerate tremendous soil load. The powerful micelle cleaning action of ***SC-1000***™ will cause long chain hydrocarbon soils including fats, greases, oils, and sugars to repel from the surface so that it can rinsed away with water, without damaging or reacting with the cleaning surface. ***SC-1000*** is not a typical caustic detergent or petroleum solvent, therefore it will not damage or react with the cleaning surface. ***SC-1000***™ meets with the following requirements:

- USEPA Design for the Environment (DfE)
- UEEPA National Oil & Hazardous Substances Pollution Contingency Plan (NCP) [1]
- USDA A1 General Cleaning & L1 Drain/Sewer Acceptable
- GSA SIN 375-361& 375-363
- California's SCAQMD as a Clean Air Solvent.
- OSHA 29-CFR Ch. XVII 1910.1200 and 40 CFR Ch. 1, Subparts C & D
- USEPA 600, 4-90, 027 for aquatic toxicity
- USEPA 601 & 602 for VOC testing

[1] ***SC-1000***™ is on the USEPA NCP Product Schedule under Surface Washing Agents. This listing does not mean that EPA approves, recommends, licenses, certifies or authorizes the use of ***SC-1000***™ on an oil discharge. The listing means only that data has been submitted to EPA as required by Subpart J of the NCP § 300.915.

INSTRUCTIONS: Rinse surface to remove loose soil before cleaning. The product may be used full strength or diluted with water depending on the specific application. Less product may be necessary if factors such as increased temperature, dwell time, temperature or agitation are used. For best results, rinse with water to remove soil and residual product.

Suggested Dilutions:

Difficult Cleaning	100% - 20%
Average Cleaning	20% - 5%
Light Cleaning	5% - .5%

BASIC PROPERTIES:

Appearance:	Clear, very light amber liquid
Odor:	Mild surfactant
Water Solubility:	100%
Boiling Point:	100ºC (212ºF)
Flash Point:	None
Specific Gravity:	1.004
Relative Density:	Greater than water
pH Range:	10.2 – 10.5

***SAFE CARE®* PRODUCTS ARE:**

- Non-toxic
- Non-reactive
- Non-carcinogenic
- Readily biodegradable
- Derived from renewable resources
- Safe to use, store and dispose of

***SAFE CARE®* PRODUCTS DO NOT CONTAIN:**

- Petroleum distillates
- Glycol ethers
- Terpenes
- Synthetics
- Builders & reagents
- Caustics

The information contained herein is believed to be correct including test data conducted under controlled laboratory conditions. Users of ***SAFE CARE*** products should perform their own test(s) to determine the suitability of the product for their specific application(s). For questions: techsupport@gemtek.com

A Division of ***GEMTEK® Products***

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SAFE CARE.

Industrial Cleaners, Solvents & Specialty Products

Material Safety Data Sheet

OECD Format

Product Name:

SAFE CARE® SC-1000™ Aqueous Cleaner Concentrate

Revision Date: 07/01/05

Hazard Scale		Product Rating	
4	Extreme	Fire	0
3	High	Toxicity	0
2	Moderate	Reactivity	0
1	Slight	Health	0
0	Insignificant	Safety	0

1. IDENTIFICATION OF THE SUBSTANCE/PREPARATION AND THE COMPANY/UNDERTAKING

Supplier:

GEMTEK® Products
3808 North 28th Avenue
Phoenix, Arizona 85017 USA
www.gemtek.com - info@gemtek.com

Emergency Telephone Number: (602) 265-8586 or 800-331-7022 (in the U.S.)

2. COMPOSITION/INFORMATION ON INGREDIENTS

Chemical Name of the Substance: Proprietary Ternary Non-Ionic Surfactant Compound, which complies with OSHA 29 CFR XVII-1910.1200 Section (i) "Trade Secrets". Contains no hazardous components under current OSHA definitions. Contents include non-ionic surfactant, Tall-oil fatty acid, organic buffer, deionized water.

European Union: None of the components of this product are listed in Annex I to Directive 67/548/EEC or in Annexes II, III or V to Directive 1999/45/EC.

3. HAZARDS IDENTIFICATION

Most Important Hazards: None

Specific Hazards: May be an eye irritant. Do not spray into eyes. If irritation does occur, rinse with clean water.

4. FIRST AID MEASURES

General Advice: Product exhibits no adverse effects.

Inhalation: Non-reactive - No First Aid needed.
Skin Contact: Non-irritating - No First Aid needed.
Eye Contact: Rinse thoroughly with plenty of water.
Ingestion: Non-toxic - No First Aid needed.

5. FIRE-FIGHTING MEASURES

Suitable Extinguishing Media: The product itself does not burn.

Specific Hazards: None

Specific Methods: Product itself can be used to put out fires.

6. ACCIDENTAL RELEASE MEASURES

Personal Precautions: None needed. Caution floor may be slippery.

Environmental Precautions: None needed; non-toxic, non-hazardous in neat form.

Methods for Cleaning Up: Filter and reuse or dispose directly by flushing area with water into sewer.

7. HANDLING AND STORAGE

Technical Measures/Precautions: Normal ventilation is adequate.

Safe Handling Advice: No special handling advice necessary.

Technical Measures/Storage Conditions: Low temperature can cause handling problems. Viscosity of material will increase.

Incompatible Products: No special restrictions on storage with other products.

Packaging Material: No restrictions.

8. EXPOSURE CONTROLS/PERSONAL PROTECTION

Engineering Measures: General room ventilation is satisfactory.
Control Parameters: None needed.
Personal Protection Equipment
Respiratory: None needed.
Eye: Safety glasses may be used.
Hand: None needed.
Hygiene Measures: Avoid contact with eyes.

9. PHYSICAL AND CHEMICAL PROPERTIES

% Volatile by Volume: Nil
Boiling Point/Range: 100°C (212°F)
Color: Very light amber
Decomposition Temperature: > 348°C (658°F)
Dielectric Strength: 1500 volts @ 500 vps
Electric Conductivity: 7,500 µmhos
Evaporation Rate: 0.7 (slower than water)
Explosive Properties: None
Flash Point: None (Penske Martin Closed Cup)
Form: Slightly viscous liquid
Freezing Point: 0°C (32.0°F)
Melting Point/Range: Not Applicable
Odor: Mild surfactant odor
pH: 10.2 – 10.5 range
Relative Density: Greater than 1 (water = 1)
Specific Gravity: 1.009
Surface Tension: 29.4 dynes / cm
Vapor Density: 0.623
Vapor Pressure: 0.2 psi @ 20°C (68°F)
Viscosity: < 100 cps @ 25°C (77°F)
Water Solubility: 99.935% (completely water soluble)
Volatile Organic Compounds: Considered none measurable by U.S. EPA Methods 601, 602 and 608

10. STABILITY AND REACTIVITY

Conditions to Avoid: No decomposition occurs.
Materials to Avoid: None. Does not react with other compounds.
Hazardous Decomposition Products: None.

11. TOXICOLOGICAL INFORMATION

Acute Toxicity: Non-toxic.
Local Effects: None.
Specific Effects: None.

12. ECOLOGICAL INFORMATION

Non-toxic; non-hazardous; safe for the environment. This product is readily biodegradable according to OECD Method 301B, Modified Sturm Test and OECD Method 301C, MITI Test.

13. DISPOSAL CONSIDERATIONS

Waste from Residues/Unused Products: Can be used after filtering. Product is recyclable.

Contaminated Packaging: If recycling is not practicable, dispose of in compliance with the Environmental Protection (Duty of Care) Regulations 1991 if contaminated with hazardous materials. May be disposed of in neat form.

14. TRANSPORT INFORMATION

Not classified as dangerous in the meaning of transport regulations. US DOT Classification: 55

15. REGULATORY INFORMATION

Product complies with all known regulatory considerations and is unregulated and not listed as a Hazmat by any agency.

16. OTHER INFORMATION

For further information, contact the Headquarters of *GEMTEK*® Products

Recommended Uses: Cleaner/Degreaser/Solvent

The information provided in this Material Safety Data Sheet is correct to the best of our knowledge, information and belief at the date of its publication. The information given is designed only as guidance for safe handling, use, processing, storage, transportation, disposal and release and is not to be considered a warranty or quality specification. The information relates only to the specific material designated and is not valid for such material used in combination with any other materials or in any process, unless specified in the text.

Emergency Contact Number: 800-331-7022

SAFE CARE®

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SAFE CARE® SC-1000 Aqueous Cleaner Concentrate

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- USEPA Design for the Environment (DfE)
- UEEPA National Oil & Hazardous Substances Pollution Contingency Plan (NCP) [1]
- USDA A1 General Cleaning & L1 Drain/Sewer Acceptable
- GSA SIN 375-361& 375-363
- California's SCAQMD as a Clean Air Solvent.
- OSHA 29-CFR Ch. XVII 1910.1200 and 40 CFR Ch. 1, Subparts C & D
- USEPA 600, 4-90, 027 for aquatic toxicity
- USEPA 601 & 602 for VOC testing

[1] ***SC-1000***™ is on the USEPA NCP Product Schedule under Surface Washing Agents. This listing does not mean that EPA approves, recommends, licenses, certifies or authorizes the use of ***SC-1000***™ on an oil discharge. The listing means only that data has been submitted to EPA as required by Subpart J of the NCP § 300.915.

INSTRUCTIONS: Rinse surface to remove loose soil before cleaning. The product may be used full strength or diluted with water depending on the specific application. Less product may be necessary if factors such as increased temperature, dwell time, temperature or agitation are used. For best results, rinse with water to remove soil and residual product.

Suggested Dilutions:

Difficult Cleaning	100% - 20%
Average Cleaning	20% - 5%
Light Cleaning	5% - .5%

SAFE CARE® PRODUCTS ARE:

- Non-toxic
- Non-reactive
- Non-carcinogenic
- Readily biodegradable
- Derived from renewable resources
- Safe to use, store and dispose of

SAFE CARE® PRODUCTS DO NOT CONTAIN:

- Petroleum distillates
- Glycol ethers
- Terpenes
- Synthetics
- Builders & reagents
- Caustics

BASIC PROPERTIES:

Appearance:	Clear, very light amber liquid
Odor:	Mild surfactant
Water Solubility:	100%
Boiling Point:	100ºC (212ºF)
Flash Point:	None
Specific Gravity:	1.004
Relative Density:	Greater than water
pH Range:	10.2 – 10.5

The information contained herein is believed to be correct including test data conducted under controlled laboratory conditions. Users of ***SAFE CARE*** products should perform their own test(s) to determine the suitability of the product for their specific application(s). For questions: techsupport@gemtek.com

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Appendix D: Laboratory Reports

DATE: December 22, 2010

TITLE: Preliminary Trials - Oil Dilution and Soiling

BY: Payal Vora

PRELIMINARY TRIALS – OIL DISPERSION/DILUTION AND SOILING

PURPOSE:

The weathered crude oil collected for this study from Fort Livingston was thick and not easily spreadable on any surface. The purpose of these trials was to evaluate methods for the dilution of oil using water and odorless mineral spirits.

SAMPLES:

Weathered crude oil collected from Fort Livingston was evaluated for even application on brick samples. The brick samples used were extras or samples that had broken in transit. The samples were 1/2 inch thick with varying conditions on the cut surface.

MATERIALS AND EQUIPMENT:

Brick samples, weathered crude oil, tap water, odorless mineral spirits, high shear mixer, containers for mixing oil and water/mineral spirits, weighing scale/balance, spatulas, 0.025 inch (25 mil) drawdown tool, shallow trays for holding samples in oven, heat resistant gloves, artificial weathering chamber.

PROCEDURE:

Oil dilution

Three approaches were used as follows:

1. Oil + water, 1:5 ratio.

The 1:5 ratio was selected as a starting point to see whether the oil would disperse at all, and if so, whether the oil-to-water ratio needed to be increased or decreased.

The oil and water were heated in separate containers at 90°F in a Fisher Scientific Isometric oven. The heated water was added to the heated oil and mixed for 5 minutes using a Silverson L4R high shear mixer. The oil and water did not mix, so the water was discarded and the oil was collected in a separate container with the intention of using it for the oil and mineral spirits trials described below, in order to minimize wastage of oil (Figure D.2).

Figure D.1. Oil and water after mixing with a high shear mixer

Figure D.2. Oil collected after discarding water

2. Oil heated to 90°F

Undiluted oil heated to 90°F was also evaluated as an option for coating. Five samples were soiled with the undiluted heated oil using a drawdown tool described below.

3. Oil + odorless mineral spirits

Odorless mineral spirits (OMS) was gradually added to the known mass of oil collected as noted above, until the mixture was easily spreadable, which was with 75% oil and 25% mineral spirits. The oil and mineral spirits mixture was used for a drawdown trial on a brick sample, described below under Soiling Tests. At the time of these trials, viscosity measurements on the oil and mineral spirits mixture were not feasible.

Figure D.3. Oil and mineral spirits mixture

Soiling and Weathering Trials

Soiling and weathering trials were performed as described below on two groups of samples:

1. Oil heated to 90°F

The five samples soiled with oil heated to 90°F were soiled using a Precision Gage & Tool Company #24 8-path drawdown applicator. One sample was soiled using the 0.050 inch (50 mil) gap on the applicator, and four samples were soiled using the 0.025 inch (25 mil) gap on the same applicator. The 50 mil gap results in the coating thickness of 25 mils, and the 25 mil gap results in a coating thickness of 12.5 mils[1]. The samples were placed in a 77° C oven to check the wet flow

[1] http://www.pgtgage.com/GrndGage.pdf

in accordance with test number 19 of *ASTM D2939-03 Standard Test Methods for Emulsified Bitumens Used as Protective Coatings*.

Figure D.4. Draw-down using the 25 mil gap of a draw-down tool

2. Oil + mineral spirits mixture

Five samples were soiled with the oil and mineral spirits mixture made as described above, using the 0.025 inch drawdown path (Figure D.4). The samples were placed in a horizontal position for approximately 5 minutes prior to being placed vertically for an additional 5 minutes to check for slump. No slump was observed so the samples were placed in the Weather-Ometer (WOM) as shown in Figure D.5, to verify if any slump or dripping of oil would occur later. The samples were left to weather in the WOM for 15 hours, to examine the effects on the soiling and on brick.

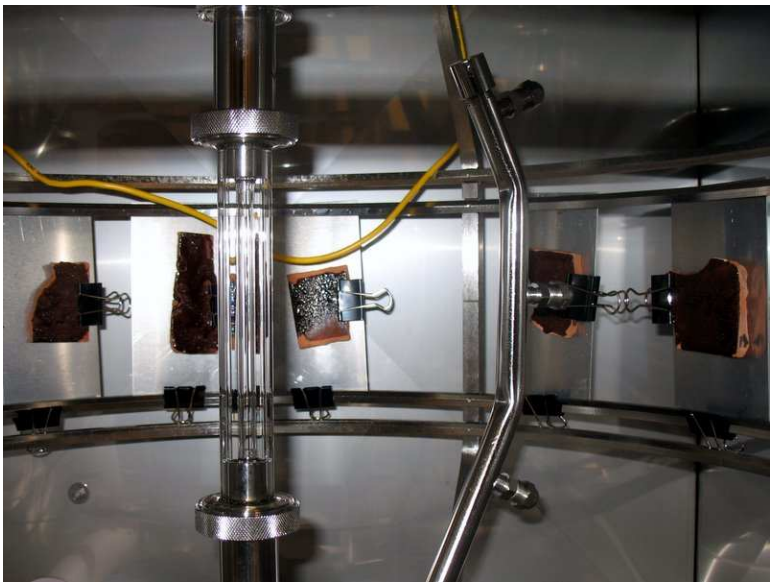

Figure D.5. Samples in the WOM, prior to weathering

TEST RESULTS:

Oil dispersion/Dilution

The results of the two approaches for oil dispersion/dilution are described below:

1. Oil + water, 1:5 ratio

After going through the high shear mixer with water, the oil was less gritty and appeared smoother. Overall, the results of the 1:5 ratio of oil and water mixed in a high shear mixer were not favorable because the oil remained separate from the water and most of it stuck to the mixer blade and the can, as shown in Figure D.1.

2. Oil + mineral spirits

The addition of mineral spirits made the oil less viscous and likely to be spreadable on the brick surface. The optimal ratio of oil to mineral spirits should be determined via additional mixtures with varying quantities of mineral spirits.

Soiling and Weathering Trials

Results of the soiling and weathering trials performed on two groups of samples are described below:

1. Oil heated at 90°F

One sample was soiled using a 0.050 inch drawdown tool and four samples were soiled using a 0.025 inch drawdown tool prior to being evaluated for oil slump. As shown below, during the wet flow test, nearly all the oil slumped off the samples (Figure D.6).

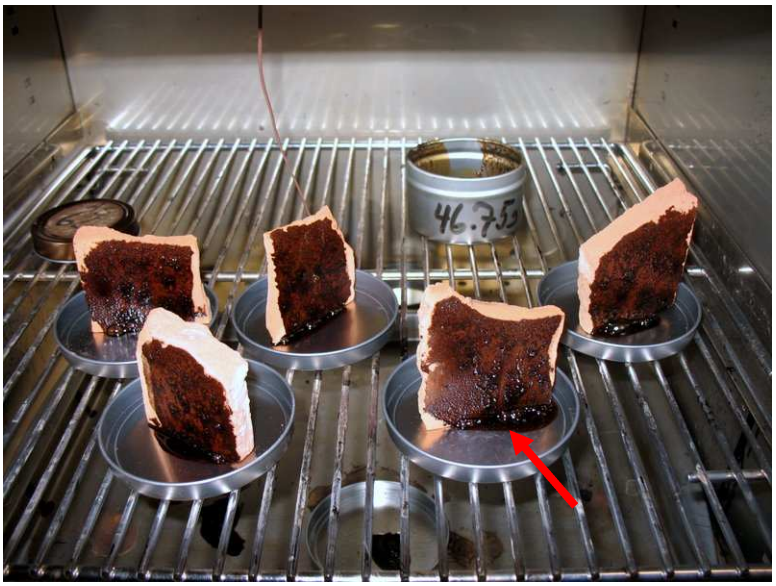

Figure D.6. Oil slumped off from samples

Due to the high viscosity of the oil, even after heating, the oil does not appear to be suitable for depositing in a thin, even layer on the brick. As a result, the excess oil slumps from the brick surface when the samples are vertically oriented and exposed to heat. Additional evaluations will be performed to prevent dripping of oil from samples when they are oriented vertically in the WOM.

2. Oil + mineral spirits mixture

As shown in Figure D.7, the coating of the oil and mineral spirits mixture was not uniform on the brick surface due to variations in the surface of the brick. This condition may be inevitable for this study because of variations in the cut surfaces of each brick sample.

Additionally, the quantity of mineral spirits in this mix may be the upper limit because the mixture spread very - almost too – easily. The lower limit of mineral spirits should be evaluated through additional trials. Eventually, the optimal ratio of oil to mineral spirits should be determined in order to maximize the quantity of oil deposited on the brick surface.

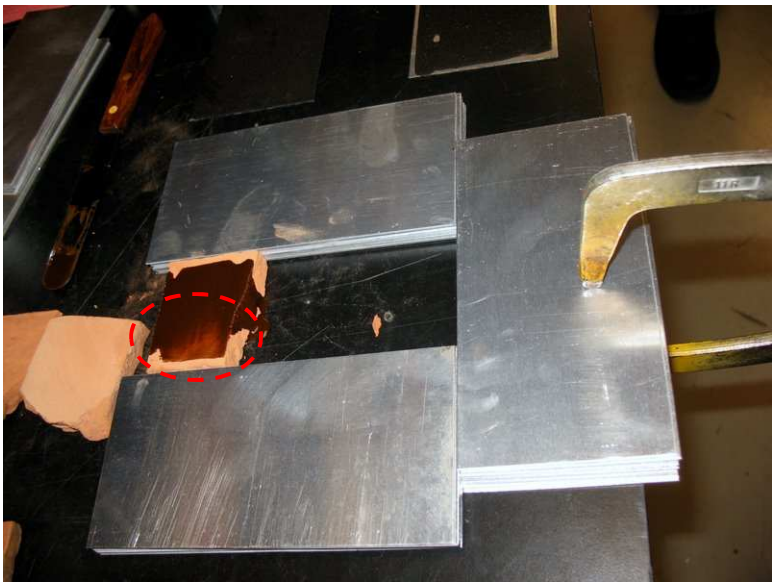

Figure D.7. Sample after 25 mil draw-down. Note: the coating is not uniform due to variations in the brick surface.

As noted above, the samples soiled with the oil and mineral spirits mixture were placed in the WOM to check for loss of oil from the brick surface due to dripping. Loss of oil from the brick surface is not desirable because it would cause variations in the quantity of oil remaining on each brick, thus causing inconsistencies in the final results. As shown below, no oil had dripped from the soiled samples that were weathered in the WOM for 15 hours (Figure D.8 and Figure D.9).

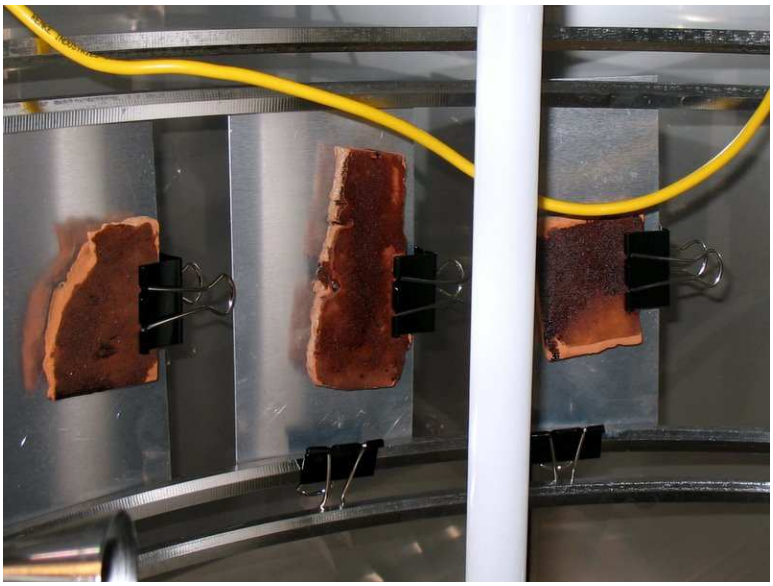

Figure D.8. Samples after weathering for 15 hours

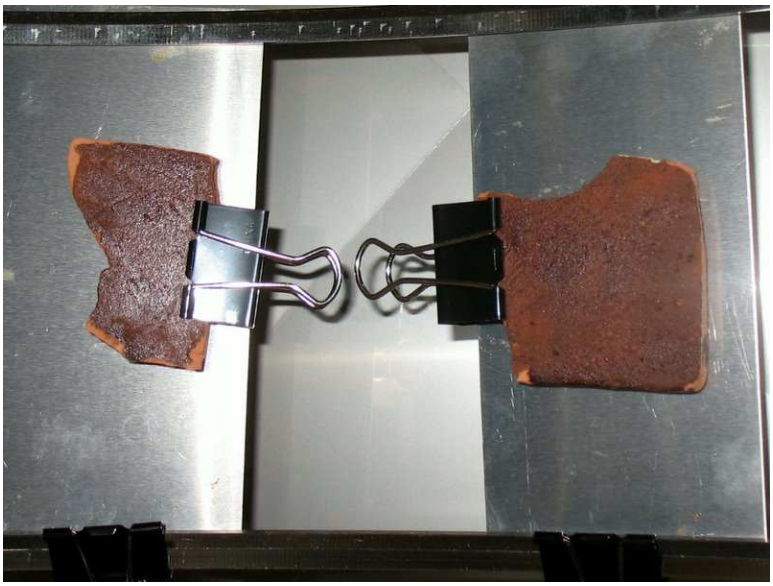

Figure D.9. Samples after weathering for 15 hours

Additional Trials

Additional trials are necessary to determine the optimal ratio of mineral spirits to oil, on samples that will be weathered for an extended period of time. Based on the above results, three different ratios of mineral spirits to oil will be evaluated: 5%, 10%, and 15% mineral spirits, which is lower than the 25% mineral spirits to oil ratio that was evaluated. Due to limited sample availability, as shown in Figure D.10, a total of six samples (two samples for each ratio), soaked

for 24 hrs in water with 3.4% salinity will be evaluated. The mineral spirits and oil mixture will be deposited on the brick surface with a 25 mil drawdown tool and the samples will be weathered for 10 days in accordance with ASTM G155 Cycle 1. The WOM used for this study including all the trials, has not been used prior to this study, and during initial weathering trials of the five samples described above, fluctuations were observed in the relative humidity (RH). Therefore, a longer weathering trial of 10 days will be performed to evaluate any ongoing RH fluctuations.

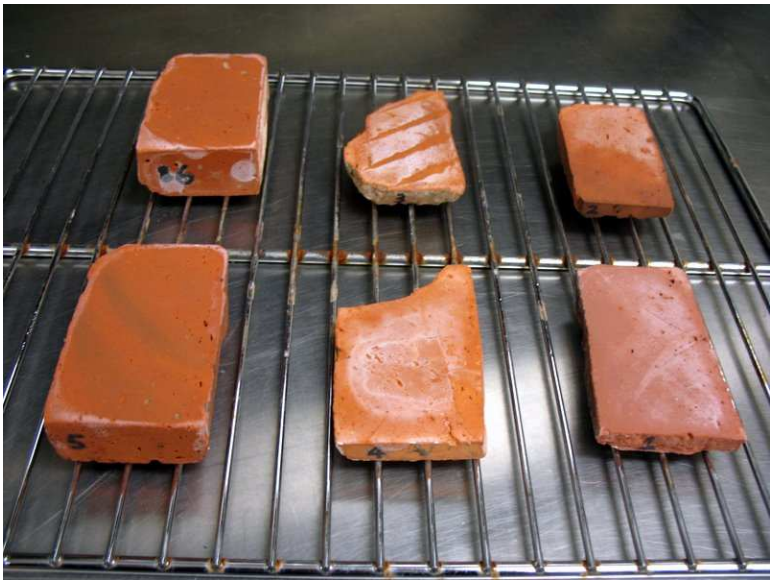

Figure D.10. Six samples for additional soiling and weathering trials, prior to soaking

DATE: January 9, 2011

TITLE: Soiling, Weathering, and Initial Cleaning Trials

BY: Payal Vora

SOILING, WEATHERING, AND INITIAL CLEANING TRIALS

PURPOSE:

The purpose of this series of trials was to develop a methodology for soiling and weathering brick samples. Initial cleaning trials on soiled samples were also conducted using selected surface washing agents (SWA, cleaner).

SAMPLES:

Selected SWA and brick samples of 3-3/4 x 2-1/2 x 1/2 inches

MATERIALS AND EQUIPMENT:

Conditioning: tap water, commercial sea salt, brick samples, weighing scale/balance, oven, heat resistant gloves, pan for soaking brick, colorimeter

Soiling: 0.025 inch (25 mil) drawdown tool, microspatula, cleaned and conditioned brick samples, weathered crude oil (oil), weighing scale/balance, colorimeter

Weathering: artificial weathering chamber, soiled brick samples, stainless steel sample plates, fasteners

Cleaning: 100 mL glass beakers, plastic transfer pipettes, sea salt, tap water, SWA samples, soiled and weathered brick samples, soft-bristled toothbrushes, wide-mouth container or pan (to collect rinse-water)

PROCEDURE:

Sample Conditioning and Soiling

Six samples (1-STR through 6-STR) were prepared for soiling, weathering, and cleaning by soaking six brick samples in 3.2%-3.4% saline water (mixture of commercial sea salt and tap water) for 24 hours (Figure D.11). Weight and water absorption data for all samples is given in

Table D.1. Colorimetry was done on samples prior to soaking, after soaking/prior to soiling, after soiling/prior to weathering, and after weathering.

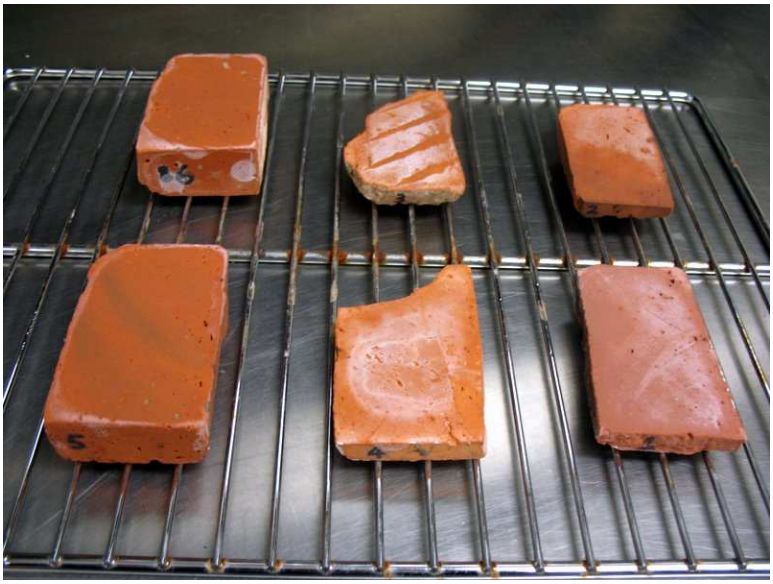

Figure D.11. Samples for additional trials, prior to soaking. Note: the stripes on the brick surface are from contact with the steel rack.

Table D.1. Samples for soiling, weathering, and cleaning trials

	Soiling and Weathering					Soiling Mixtures	
Sample ID#	**Dry Wt (g)**	**Wet Wt (g)**	**% absorp.**	**Soiled Wt (g)**	**240 hr. Weathered Wt (g)**	**Mineral Spirits (%)**	**Kinematic Viscosity (cSt)**
1-STR	101.09	117.08	15.82	117.83	102.00	5	492.77
2-STR	98.68	113.04	14.55	113.24	99.11		
3-STR	78.93	94.97	20.32	95.07	79.65	10	144.85
4-STR	88.84	104.29	17.39	103.70	90.27		
5-STR	207.62	241.82	16.47	240.77	208.54	15	55.49
6-STR	236.01	275.88	16.89	274.61	237.40		

Based on results of previous trials, during this trial, mineral spirits were added to the oil in three different ratios to determine an optimal percentage: 5%, 10%, and 15%. Kinematic viscosity was measured for each of the mixtures and is shown in Table D.1. Two samples were soiled per percent quantity of mineral spirits.

1 gram of the oil and mineral spirits mixture was dispensed onto each sample using a microspatula, and spread on the sample surface using a 0.025 inch (25 mil) drawdown tool. Soiled samples prior to weathering are shown in Figure D.12.

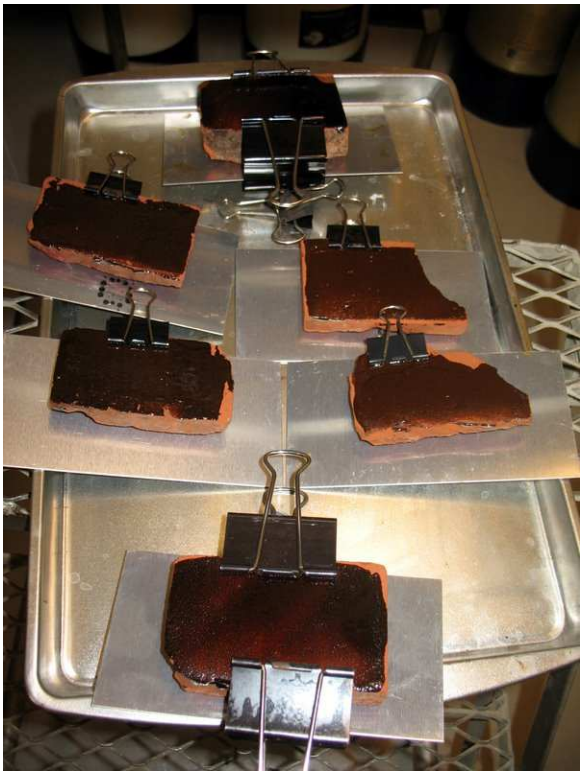

Figure D.12. Soiled samples prior to weathering for 240 hours

Weathering

The six samples (1-STR through 6-STR) soiled as described above were weathered for 240 hours (10 days) in accordance with ASTM G155 Cycle 1. Cycle 1 parameters as given in ASTM G155 are shown below in Figure D.14.

After weathering, five colorimeter readings were taken on each of the six soiled and weathered samples. Additionally, the samples described in the previous report dated December 22, 2010, which were weathered for 15 hours as a part of the initial soiling and weathering trials were artificially weathered for an additional 240 hours, for a total of 155 hours. These samples, labeled 6 through 10, are shown in Figure D.13.

Figure D.13. Soiled samples 6 through 10 after weathering for 255 hours

These samples were pieces of broken bricks that could not be used for formal trials and were not soaked, weighed etc. prior to soiling and weathering. No colorimetry data has been collected on this group of samples. The samples in this group were weathered with the intention of using them as “sacrificial” samples for very preliminary cleaning trials to get a feel for the cleaning process.

TABLE X3.1 Common Exposure Conditions

Cycle	Filter	Irradiance	Wavelength	Exposure Cycle
1	Daylight	0.35 W/m^2· nm	340 nm	102 min light at 63°C Black Panel Temperature 18 min light and water spray (air temp. not controlled)
2	Daylight	0.35 W/m^2· nm	340 nm	102 min light at 63 °C Uninsulated Black Panel Temperature 18 min light and water spray (air temp. not controlled); 6 h dark at 95 (±4.0) % RH, at 24 °C Uninsulated Black Panel Temperature
3	Daylight	0.35 W/m^2· nm	340 nm	1.5 h light, 70 % RH, at 77 °C Black Panel Temperature 0.5 h light and water spray (air temp. not controlled)
4	Window Glass	0.30 W/m^2· nm	340 nm	100 % light, 55 % RH, at 55° C Black Panel Temperature
5	Window Glass	1.10 W/m^2· nm	420 nm	102 min light, 35 % RH, at 63 °C Black Panel Temperature 18 min light and water spray (air temp. not controlled)
6	Window Glass	1.10 W/m^2· nm	420 nm	3.8 h light, 35 % RH, at 63 °C Black Panel Temperature 1 h dark, 90 % RH, at 43 ° C Black Panel Temperature
7	Extended UV	0.55 W/m^2·nm	340 nm	40 min light, 50 (±5.0) % RH, at 70 (±2) °C Black Panel Temperature and 47 (±2) °C Chamber Air Temperature 20 min light and water spray on specimen face; 60 min light, 50 (±5.0) % RH, at 70 (±2) °C Black Panel Temperature; and 47 (±2) °C Chamber Air Temperature 60 min dark and water spray on specimen back, 95 (±5.0) % RH, 38 (±2) °C Black Panel Temperature and 38 (±2) °C Chamber Air Temperature
7A	Daylight	0.55 W/m^2·nm	340 nm	40 min light, 50 (±5.0) % RH, at 70 (±2) °C Black Panel Temperature and 47 (±2) °C Chamber Air Temperature 20 min light and water spray on specimen face; 60 min light, 50 (±5.0) % RH, at 70 (±2) °C Black Panel Temperature; and 47 (±2) °C Chamber Air Temperature 60 min dark and water spray on specimen front and back, 95 (±5.0) % RH, 38 (±2) °C Black Panel Temperature and 38 (±2) °C Chamber Air Temperature
8	Extended UV	0.55 W/m^2·nm	340 nm	3.8 h light, 50 (±5.0) % RH, at 89 (±3) °C Black Panel Temperature and 62 (±2) °C Chamber Air Temperature 1.0 h dark, 95 (±5.0) % RH, at 38 (±2) °C Black Panel Temperature and 38 (±2) °C Chamber Air Temperature
9	Daylight	180 W/m^2(at 300–400 nm)	300–400 nm	102 min light at 63 °C Black Panel Temperature 18 min light and water spray (temperature not controlled)
10	Window Glass	162 W/m^2(at 300–400 nm)	300–400 nm	100 % light, 50 % RH, at 89 °C Black Panel Temperature
11	Window Glass	1.5 W/m^2· nm	420 nm	Continuous light at 63 °C uninsulated black panel temperature, 30 % RH
12	Daylight	0.35 W/m^2· nm	340 nm	18 h consisting of continuous light at 63°C uninsulated black panel temperature 30 % RH 6 h dark at 90 % RH, at 35 °C dry bulb temperature

Figure D.14. ASTM G155 Cycles and parameters

Cleaning

For cleaning trials on the above mentioned sacrificial samples six cleaners were chosen out of the ten cleaner samples received; details of cleaners chosen and application methods are given in Table D.2. All cleaner samples are listed on the Environmental Protection Agency (EPA) NCP Product Schedule[1].

As required, cleaners were diluted using tap water according to EPA and manufacturer recommended ratios. All cleaners were applied to the soiled brick using concentration and dwell-time for each product as listed in the NCP Product Schedule. After application and dwelling of

[1] http://www.epa.gov/ceppo/web/content/ncp/product_schedule.htm

cleaners as recommended, the surface of each brick sample was scrubbed with a synthetic soft-bristle toothbrush, using a circular scrubbing motion.

Table D.2. Cleaners and cleaning trials

Sample #	Cleaner	Dilution	Dwell time (minutes)	Method recommended	Method used
6	CleanGreen Planet Wash	1:10	N/A	Pump/Spray	brushed on then agitated with toothbrush
7	E Safe	Full-strength	till product penetrates surface - visually evaluate	Spray, soak with water	sprayed, soaked surface by dispensing water with pipette, then agitated with toothbrush
8	Procleans	1:10	N/A	Press. washer	brushed on then agitated with toothbrush
9 (wide half)	Petro-Clean	6%	5	Spray	brushed on then agitated with toothbrush
9 (narrow half)	Environmental 1 Crude Oil Cleaner	Full-strength	N/A	Spray	brushed on then agitated with toothbrush
10	SC-1000	1:5	5	Spray	brushed on then agitated with toothbrush

There were five sacrificial samples and six cleaners so sample 9 was divided into two parts to evaluate two different cleaners. One of the cleaners used on sample 9 was a gel to be used at full strength and was not very runny.

TEST RESULTS:

Sample Conditioning and Soiling

As shown in Table D.1, the viscosity trend for the three mixtures with different mineral oil content is as expected. The mixture with 5% mineral spirits was the most viscous and the mixture with 15% mineral spirits was the least viscous.

The following additional observations were made during this trial that should be considered during the development of soiling methodology for the experimental samples. Related questions are also noted below.

1. Water evaporated from the samples between the following steps: removal from water, colorimetry, and soiling, so the soiled weight is close to the wet weight. *Does this weight loss due to evaporation matter? If I record the weight prior to soiling I would know how*

much water evaporated during the colorimetry and soiling prep steps. I cannot premix the oil and mineral spirits because of evaporation of mineral spirits.

2. Evenness of soiling varies due to variations in sample surface.
3. 1 gram of the oil and mineral spirits mixture was dispensed onto each sample. However, the entire quantity did not get applied; some remained on the drawdown tool. *Does this matter as long as I weigh the final soiled sample?*
4. The 5% mixture was not impossible to spread, but took noticeably longer and required at least 2 drawdowns before the oil spread across the entire sample surface. The 15% mixture was very thin however the 10% mixture appeared to have a suitable viscosity. *I want to try a mixture with 7.5% mineral spirits to see how well that works in terms of quality of soiling.*
5. I measured kinematic viscosity. *I can calculate absolute viscosity from kinematic viscosity but I need the actual mixtures for kinematic and since I already had the mixtures I measured kinematic simultaneously with soiling. I will have absolute viscosity values.*

Weathering

When the samples were put into the WOM, the RH was fluctuating between 25% and 10% instead of staying at 50%. The cause of the problem was identified and has been resolved. The RH was stable around 50% in the last 5 days of the 10-day weathering cycle.

The following additional observations were made during this trial that should be considered during the development of weathering methodology for the experimental samples. Any related questions are also noted below.

1. Locations where the samples are held by the clip may leave a darker noticeable area after weathering. *I am minimizing this by clipping samples onto holders using as less area as possible. It cannot be completely prevented using the current method of clipping samples onto the holders.*

Cleaning

The six cleaners were chosen based on relevance/target application (e.g. CleanGreen Planet Wash was formulated for the Exxon Valdez oil spill and is relevant; Magic Sheen is meant for application on water and is not relevant), ease of application, and ease of collecting effluence. Cleaners that required overnight dwelling or dwell times longer than a few minutes were not chosen because at Fort Livingston, tide cycles limit cleaner dwell times. Long dwell times on porous brick would result in cleaner being absorbed by the brick which would make it difficult to rinse off. Additionally, long dwell times at high ambient temperatures might at least partially dry the cleaner from the brick surface, and require re-application or rinsing with water prior to agitating or scrubbing.

Tap water was used for diluting cleaners rather than sea water because sea water affected by an oil spill is likely to be already contaminated with oil and not feasible for use in cleaning mixtures. All samples were scrubbed with a soft-bristle brush even if scrubbing/agitation was not mentioned in the EPA or manufacturers' recommendations because cleaner application and rinsing without scrubbing did not appear to loosen the soiling from the brick surface.

Figure D.15 shows samples 6 through 8 before cleaning and Figure D.16 show samples 6 through 8 after cleaning.

Figure D.15. Samples 6 through 8 before cleaning

Figure D.16. Samples 6 through 8 after cleaning

Figure D.17 shows samples 8 through 10 before cleaning and Figure D.18 shows samples 8 through 10 after cleaning. All cleaned samples appear darker because they were still wet when I photographed them after cleaning.

Figure D.17. Samples 8 through 10 before cleaning

Figure D.18. Samples 8 through 10 after cleaning

The following additional observations were made during this trial that should be considered during the development of cleaning methodology for the experimental samples. Any related questions are also noted below.

1. Each cleaner was diluted in accordance with parameters listed in the NCP Product Schedule to make a total of 4-5 mL cleaning solution. The entire quantity of cleaner solution was used on each sample. *How do I determine the appropriate quantity of cleaning solution to use per sample?* (Fran Gale (FG) response: You probably cannot; it is better to use a standard amount.)
2. On soiled samples, the cleaners do not have a noticeable effect without agitation with a soft-bristled brush. *Should I strictly adhere to EPA or manufacturers' recommendations and not scrub/agitate unless specifically recommended?* (FG response: This has already been addressed.)
3. Certain cleaners required a longer agitation/scrubbing than others, before any cleaning action was noticed. *I should use the same scrubbing times for each cleaner in order to compare cleaner efficacy even if I don't see any cleaning action from certain cleaners. Or, drop those cleaners and choose from the remaining 4 cleaners.*
4. Application of certain cleaners is recommended using a pressure washer. *How do I simulate this in the lab? Can I use a spray bottle instead? Is that even close to pressure washing?* (FG response: You did, by using spray and brush.)
5. As expected, used at recommended ratios, certain cleaners have a greater efficacy than others. *Should I try higher concentrations? I have only one set of samples (5 replicates + 1 control) per cleaner so I can only try one concentration per cleaner.*

ARCHITECTURAL CONSERVATION LAB
HISTORIC PRESERVATION PROGRAM
SCHOOL OF ARCHITECTURE
THE UNIVERSITY OF TEXAS AT AUSTIN

DATE: January 14, 2011

TITLE: Laboratory Trials - Cleaner and Oil Interaction

BY: Payal Vora

LABORATORY TRIALS - CLEANER AND OIL INTERACTION

PURPOSE:

The purpose of this series of trials was to evaluate the interaction between weathered crude oil (oil) and surface washing agents (SWA, cleaner). The evaluations were performed based on manufacturers' recommendations or Environmental Protection Agency (EPA) guidelines for product application as published in the NCP schedule (Table D.3).

SAMPLES:

Ten SWA shown in Table D.3 were evaluated. The SWA were selected from the National Contingency Plan (NCP) product schedule[1] after reviewing product technical data. Additionally, a commonly used laboratory glassware cleaner, Micro-90, was also evaluated for comparison, based on the recommendation of Carol Chin (NCPTT).

MATERIALS AND EQUIPMENT:

Various glass beakers, test tubes, plastic transfer pipettes, 1 mL calibrated pipette, magnetic stirrer, vibrating stirrer, SWA samples, weathered crude oil

PROCEDURE:

Interactions between SWA and oil were evaluated at the National Center for Preservation Technology and Training (NCPTT) labs on January 14 and 15, 2011. The general procedure for evaluation of oil and cleaners is described below. Specific procedures and results for selected cleaners are described in the next section of this report.

Unless otherwise noted, cleaners were diluted with tap water according to manufacturer or EPA recommended ratios. The highest recommended dilution ratio was used in case of a recommended range of dilution ratios. The consistency of the oil at ambient temperature was similar to that of cold peanut butter.

[1] http://www.epa.gov/ceppo/web/content/ncp/product_schedule.htm

Unless otherwise noted, oil and cleaner were mixed in equal quantities in a beaker and agitated using the vibrating mixer in 15 second increments until the oil and cleaner mixed or until the cleaner dissolved the oil. Additional cleaner solution was added in 1 mL increments as required, to examine the effect.

TEST RESULTS:

Results from the cleaner evaluations performed at NCPTT are shown in Table D.3 and described below.

Table D.3. Cleaner and Oil Interaction Trials

		Recommended Dilution					
No.	**Product**	**Mfr.**	**EPA**	**Recommended dwell time**	**Cleaner Quantity (mL)**	**Oil Quantity (g)**	**Total Agitation Time**
1	BioSolve	6%	6%			1	
2	Clean Green Planet Wash	1:10 or 1:20	1:10			1	
3	Cytosol	1:1**	Full strength	20 hours		1	1 minute
4	E-Safe	Full strength	Full strength	till product penetrates surface - visually evaluate		1	
5	Environmental 1	1:8	Full strength			1	
6	GoldCrew	1:8	1:20	60 minutes		1	
7	Nale-It	--	1:20			1	
8	Petro-Clean	1:4	6%		3	1	1 hr, 2 minutes
9	Proclean PCR 107	1:20	1:10			1	
10	SC-1000	1:1**	20%			1	
11	Micro-90	2%		20 hours	5	1	

** According to recommendations by manufacturers' representative in conversation with F. Gale

Petro-Clean

The first trial was done with Petro-Clean by mixing equal parts of oil and Petro-Clean solution in a beaker, and agitating using a vibrating stirrer for a total of 2 minutes. This resulted in no interaction between the oil and cleaner, and the oil remained in a viscous mass. The same mixture was heated to 90 C and simultaneously agitated for an additional hour using a magnetic stirrer

with a hot plate. As shown in Figure D.19 and Figure D.20, the oil and cleaner had minimal, if any, interaction. The mixture was left to soak overnight for approximately 20 hours, with no effect.

Figure D.19. Oil and Petro-Clean solution in equal parts

Figure D.20. Oil and Petro-Clean after stirring on a vibrating mixer and magnetic stirrer, for a total of 1 hour, 2 minutes

SC-1000

The next trial was done with SC-1000 by mixing equal parts of oil and SC-1000 solution in a beaker. Per the recommendation of the manufacturer's representative, the oil was allowed to soak in the cleaner solution for 1 hour and agitated using a vibrating stirrer for a total of 2 minutes. This resulted in no interaction between the oil and cleaner, and the oil remained in a viscous mass in the SC-1000 solution. The same mixture was heated to 90 C and simultaneously agitated for an additional hour using a magnetic stirrer with a hot plate. As shown in Figure D.21 and Figure D.22, the oil and cleaner had minimal, if any, interaction. This mixture was also left to soak overnight for approximately 20 hours, with no effect.

Figure D.21. Oil and SC-1000 solution in equal parts

Figure D.22. Oil and SC-1000 after soaking for 1 hour

Cytosol

The third trial was done with Cytosol by mixing equal parts of oil and full-strength Cytosol in a beaker (Figure D.23). Per the recommendation of the manufacturer's representative, the oil was allowed to soak in the Cytosol overnight for approximately 20 hours and mixed with an equal quantity of water. The oil, Cytosol and water mixture was manually agitated using a plastic spatula for a total of 1 minute. The oil had softened overnight in the Cytosol and readily mixed with the cleaner (Figure D.24 and Figure D.25Figure).

Figure D.23. Oil and Cytosol mixture

Figure D.24. Oil and Cytosol after soaking for 20 hours

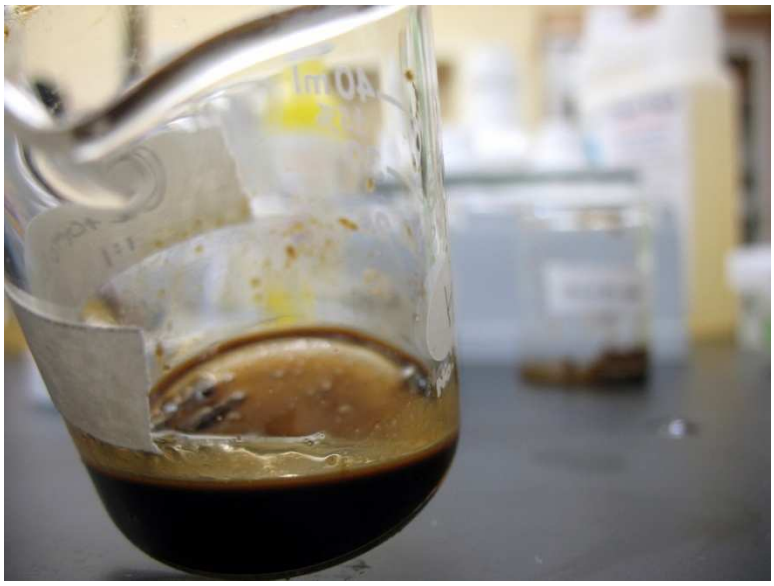

Figure D.25. Oil and Cytosol after soaking for 20 hours and manually agitated for 1 minute after adding an equal amount of water

Micro-90

Micro-90 (pH = 9.5)is not on the NCP product schedule however it was tried in the lab based on the recommendation of Carol Chin because it is commonly and successfully used in the NCPTT labs to clean chemical residue including oil from lab glassware. It is water soluble and the typically diluted with water to a 2% solution. According to the manufacturer, it removes oil, grease, wax, flux, particulates, hard water stains and biological debris from glass, ceramic, metal, plastic, precision parts, lab ware, processing equipment, and filter membranes.

Oil and a 2% solution of Micro-90 were mixed in equal parts and allowed to soak overnight for 20 hours. As shown in Figure D.27, the oil did not look softened however a film had formed on it, likely from the interaction of Micro-90 with the oil. The mixture was manually agitated for 1 minute with a plastic spatula however the oil had not softened at all and no interaction was observed between the oil and Micro-90 (Figure D.28).

Figure D.26. Oil and Micro-90 before soaking overnight

Figure D.27. Oil and Micro-90 after soaking overnight for 20 hours. Note the film on oil mass, which is a different colour than the oil.

Figure D.28. Oil and Micro-90 after soaking overnight for 20 hours and being manually mixed for 2 minutes

DISCUSSION OF RESULTS:

In general, the cleaners will likely have a different action when applied to the soiled brick surface and scrubbed. Additional laboratory trials similar to those described in this report will be done at the University of Texas at Austin to examine the interaction between cleaners and oil. An experimental approach for this will be developed with the help of Fran Gale.

DATE: February 2, 2011

TITLE: Evaluation of Oil and Cleaner Interaction

BY: Payal Vora

EVALUATION OF OIL AND CLEANER INTERACTION

PURPOSE:

The purpose of this analysis was to evaluate the interaction between selected Surface Washing Agents (SWA, cleaner) and other cleaners in order to select cleaners for evaluation on brick samples soiled with weathered crude oil (oil).

SAMPLES:

A total of fourteen cleaners were evaluated as noted in the previous report, after review of product technical data. The following ten cleaners from the Environmental Protection Agency's (EPA) National Contingency Plan (NCP) Product Schedule were evaluated:

1. BioSolve
2. Clean Green Planet Wash
3. Cytosol
4. Environmental 1
5. E-Safe
6. GoldCrew
7. Nale-It
8. Petro-Clean
9. Proclean PCR 107
10. SC-1000

Additionally, the following four cleaners that are not on the NCP Product Schedule were evaluated for comparison, because they were used in field tests by NCPTT however the interaction of each cleaner with oil has not previously been evaluated in the laboratory:

1. De-Solv-It Cleaner
2. Goo Gone
3. Green Terpene d-limonene
4. VeruSOLVE

MATERIALS AND EQUIPMENT:

2 dram glass vials, test tubes, cleaners, microspatula, weathered crude oil

PROCEDURE:

Interaction between each cleaner and oil was evaluated by manually agitating for approximately 30 seconds, a small quantity of oil (≤ 1.5 g) with approximately 4 mL of undiluted cleaner in a vial or test-tube. The mixture was allowed to dwell for 24 hours prior to making observations.

TEST RESULTS:

The d-limonene-based cleaners including Green Terpene, Goo Gone, and De-Solv-It dissolved the oil fastest, within less than 15 minutes of agitation. Cytosol dissolved oil within 2 hours. Other cleaners reacted more slowly, but are not ineffective at dissolving the oil. Some of the cleaners including Environmental 1, VeruSOLVE, and Nale-It did not dissolve the oil even after 24 hours.

Figure D.29. Cleaners and oil after agitation, showing cleaners that dissolved oil within a dwell time of 15 minutes to 24 hours

Figure D.30. Cleaners and oil after agitation, showing cleaners that dissolved oil within a dwell time of 15 minutes to 24 hours

Figure D.31. Cleaners and oil after agitation and 24 hours dwell, showing cleaners that did not dissolve oil after the 24 hour dwell

Figure D.32. Cleaners and oil after agitation and 24 hours dwell, showing cleaners that did not dissolve oil after the 24 hour dwell

DISCUSSION OF RESULTS:

All cleaners for evaluation on soiled brick were selected from the NCP Product Schedule. Although all oil and cleaner mixtures were allowed to dwell for 24 hours, the cleaners listed below dissolved approximately 90% oil within 6 hours. The cleaners that did not dissolve oil even after 24 hours were not selected for evaluation on brick. Based on the above results, the following seven cleaners from the NCP Product Schedule were selected for further evaluation on brick soiled with oil. The selected cleaners range from those with a high rate of oil dissolution to those with a low rate of oil dissolution.

BioSolve
Clean Green Planet Wash
Cytosol
E-Safe
GoldCrew
Petro-Clean
SC-1000

Two additional products, De-Solv-It Industrial Formula and De-Solv-It All Purpose Cleaner (APC) Super Concentrate, recently added to the NCP Product Schedule were also included in the evaluation of cleaners on brick soiled with weathered crude oil. Both products are d-limonene

based cleaners and based on the interaction of oil and d-limonene shown above, are worth evaluating on soiled brick.

For this study, all cleaners were used neat (without diluting), however during the subsequent evaluation of the above selected cleaners on soiled brick, each cleaner will be diluted, applied, and allowed to dwell on the soiled surface per EPA recommendations (or manufacturer's recommendations in absence of EPA recommendations).

DATE: February 28, 2011

TITLE: Preliminary Cleaner Evaluation and Final Selection

BY: Payal Vora

PRELIMINARY CLEANER EVALUATION AND FINAL SELECTION

PURPOSE:

The purpose of this analysis was to make a final selection of six Surface Washing Agents (SWA, cleaner) for the evaluation of each cleaner on brick samples soiled with weathered crude oil (oil).

SAMPLES:

Based on the results of preliminary evaluations of cleaner and oil interaction as stated in the report dated February 2, 2011, the following nine cleaners from the NCP Product Schedule were selected for evaluation on brick soiled with oil:

1. BioSolve
2. Clean Green Planet Wash
3. Cytosol
4. De-Solv-It All Purpose Cleaner (APC) Super Concentrate
5. De-Solv-It Industrial Formula
6. E-Safe
7. GoldCrew
8. Petro-Clean
9. SC-1000

The dimensions of each brick sample were 3-3/4 x 2-1/2 x 1/2 inches.

MATERIALS AND EQUIPMENT:

Brick samples, weathered crude oil, graduated cylinders and beakers of various sizes, spray bottles, cleaners, nine nylon soft bristle toothbrushes, saline solution with 3.4% salinity, timer.

PROCEDURE:

Sample Preparation

Three brick samples were evaluated per cleaner, for a total of 27 brick samples. The samples were soaked for 24 hours in saline solution with 3.4% salinity. Each sample was blotted dry prior to being soiled with 1 g of diluted oil. 30 g of oil was diluted with 10% odorless mineral spirits in order to facilitate soiling. The soiled brick were placed in an oven at 100 F for approximately 8 hours in order to evaporate the mineral spirits prior to cleaning.

Figure D.33. Soiled brick for evaluation of cleaner 1

Figure D34. Soiled brick for evaluation of cleaner 2

Figure D.35. Soiled brick for evaluation of cleaners 3 through 6

Figure D.36. Soiled brick for evaluation of cleaners 7 through 9

Cleaner Preparation and Cleaning Trials

The cleaners were diluted as shown in Table D.4; each sample was held in the vertical position throughout the cleaning trials. Each sample was pre-wet by spraying saline solution (3.4% salinity) until the sample surface appeared saturated with water. Cleaner was sprayed on the surface of the brick sample until the sample surface appeared covered with the cleaner. The cleaner was allowed to dwell as specified in Table D.4, with additional treatment (such as spraying with water or dilute cleaner) as specified by the manufacturer. The cleaner on the sample surface was agitated by hand with a plastic nylon soft bristle toothbrush using medium pressure and circular motion on the sample surface in 15-second intervals, for a total of 60 seconds.

After the first 15-second agitation, the sample surface was sprayed with the cleaner, followed by a second 15-second agitation. After subsequent agitation, if the sample surface was dry and the cleaner on the surface was difficult to agitate, saline solution was sprayed as required to enable agitation. After the last 15-second agitation, cleaner residue and loose soiling were rinsed from the sample by generously spraying saline solution on the sample surface. The sample was placed horizontally on a wire rack to dry at room temperature for at least 24 hours prior to making observations.

Based on cleaning results of the above trial, selected cleaners were applied on the samples for a second cleaning cycle. The dwell time and cleaning method for each cleaner were the same as described above for the first cleaning cycle and as shown in Table D.4.

Cleaner 9 – Clean Green Planet Wash – was not included in the first application of cleaners due to unavailability of detailed product data and application recommendations from the manufacturer or the NCP Product Schedule. However, the product was subsequently included and due to time constraints, was evaluated based on one cleaner application.

Table D.4. Surface Washing Agents (SWA, cleaner) evaluated for selection of six final cleaners.

No.	SWA	Ingredients	Solubility in Water	pH	Toxicity, LC50 ppm (silverside 96-hr; shrimp 48-hr)	Dilution	Minimum Dwell Time	Notes
1	Petro-Clean™	Mixture of water, Emulsifiers, Surfactants, Dispersants, naturally occuring micro-organisms (non-pathogenic)	100%	7.0 - 8.0 (EPA: 8.05 (10% soln))	100 96-hr; 110 48-hr	6%	≥ 45 min.	Dwell, agitate, rinse

2	CytoSol Biosolvent	Proprietary formulation of soy oil methyl esters.	7 ppm in sea water	Neutral	738 96-hr; 124 48-hr	Neat	1 h.	Dwell, agitate, rinse
3	SAFE CARE® SC-1000™	Non-ionic surfactants and seed ester alcohols	99.94%	10.2 - 10.5	26.40 96-hr; 15.20 48-hr	EPA: 20%, Mfr.: Neat for heavy soiling	1 h.	Dwell, agitate, rinse
4	GoldCrew	Proprietary blend of surfactants.	100%	9.76 ± 0.01	13.80 96-hr; 20.40 48-hr	20%	1 h. with 20% solution	Dwell, spray with 5% solution, agitate, rinse
5	De-Solv-It APC Super Concentrate	D-limonene. Biodegradable.	100%	9 - 9.5	20.95 96-hr; 30.95 48-hr	1:1	~ 15 min.	Dwell, agitate, rinse. Spray more product before agitation if required.
6	De-Solv-It Industrial Formula	D-limonene, non-ionic proprietary surfactants and solvents. Biodegradable.	None. Miscible in oil and solvents	None (EPA: 6.6)	37.71 96-hr; 4.57 48-hr	Neat	~ 15 min.	Dwell, agitate, rinse. Spray more product before agitation if required.
7	BioSolve	Water Based, Biodegradable, Wetting Agents & Surfactants	100%	9.1 ± 0.3 (EPA: 9.37 ± 0.5)	6.4 96-hr; 3.6 48-hr	6%	No recommended dwell time because according to mfr. the product reacts instantaneously.	Dosage is very important so make sure to thoroughly cover area with ample amount of product.

8	E-Safe	Proprietary blend of surfactants and organic solvents in aqueous solution; Contains 2 ppm Floresin and 2 ppm Orcoacid Orltofast Turq for identification.	Infinite	8.04	329.0 96-hr; 257.0 48-hr	Neat	Until product is no longer visible on surface	Spray product then soak surface with water to enhance product action on oil.
9	Clean Green Planet Wash	Proprietary blend of surfactants, additives, and solvents	Miscible in oil, water, and solvents	9.9	136.10-hr; 70.70-hr	1:10	Mfr. is not sure, try various dwell times up to 24 hours	Dwell, agitate, rinse

Note: all samples were pre-wet (sprayed) with saline solution before product application and dwell

TEST RESULTS:

Figures D.37 and D.38 show the brick samples after being cleaned once with cleaners 1 through 8. As noted above cleaner 9 was excluded from the first cleaning cycle due to limited product application data avaliable. However, based on results of preliminary trials of oil and cleaner interactions, cleaner 9 was subsequently evaluated and one cleaning cycle was performed with cleaner 9. Cleaner 2 and cleaner 6 appear to have removed the maximum amount of surface soiling during the first cleaning cycle. Cleaner 7 and cleaner 8 appear to have removed the least amount of surface soiling from the brick samples.

Based on the results of the first cleaning cycle, cleaners 1 through 9 can be ranked in the following order, from highest to lowest cleaning efficacy:

Cleaner 2 – Cytosol
Cleaner 6 – De-Solv-It Industrial Formula
Cleaner 4 – GoldCrew
Cleaner 5 – De-Solv-It APC Super Concentrate
Cleaner 3 – SC-1000
Cleaner 9 – Clean Green Planet Wash
Cleaner 1 – Petro-Clean
Cleaner 8 – E-Safe
Cleaner 7 – BioSolve

Figure D.37. Bricks after the first cleaning cycle with cleaners 1 through 6 (first application of each cleaner)

Figure D.38. Bricks after the first cleaning cycle with cleaners 7 and 8 (first application of each cleaner). Note: detailed product information for cleaner 9 was unavailable at the time of the cleaning evaluations so cleaner 9 was not evaluated at this time, however as shown below, it was subsequently evaluated.

As noted above, a second cleaning cycle was performed with cleaners 1, 3, 4, 5, 7, and 8 to evaluate the results of re-application of each cleaner (Figures D.39 and D.40). Cleaners 2 and 6 appeared to have removed all the surface soiling and were not included in the second cleaning cycle.

Figure D.39. Bricks after the second cleaning cycle with cleaners 1, 3, 4, and 5 (second application of each cleaner)

Figure D.40. Bricks after the second cleaning cycle with cleaners 7 and 8 (second application of each cleaner), and once with cleaner 9 (first application of cleaner 9).

Based on the results of the second cleaning cycle, cleaners 1 through 9 can be ranked in the following order, from highest to lowest cleaning efficacy:

Cleaner 2 – Cytosol*
Cleaner 6 – De-Solv-It Industrial Formula*
Cleaner 5 – De-Solv-It APC Super Concentrate
Cleaner 3 – SC-1000
Cleaner 1 – Petro-Clean
Cleaner 4 – GoldCrew
Cleaner 9 – Clean Green Planet Wash*
Cleaner 7 – BioSolve
Cleaner 8 – E-Safe

* Only one cleaning cycle was performed with these cleaners.

DISCUSSION OF RESULTS:

Cleaner 2 and cleaner 6 appeared to have cleaned the brick with the highest efficacy of all nine cleaners evaluated, and required one cleaning cycle. Cleaner 9 appeared to have performed well with one cleaning cycle however soiling was removed from the sample surface inconsistently and

in patches. Although the patches where soiling is removed by Clean Green Planet Wash are clean, the cleaner may produce unreliable results and may be difficult to use in the field.

Based on above results, the following cleaners out of nine selected from the NCP Product Schedule performed best and are listed below in order of performance:

1. Cytosol
2. De-Solv-It Industrial Formula
3. De-Solv-It APC Super Concentrate
4. SC-1000
5. Petro-Clean
6. GoldCrew

ARCHITECTURAL CONSERVATION LAB
HISTORIC PRESERVATION PROGRAM
SCHOOL OF ARCHITECTURE
THE UNIVERSITY OF TEXAS AT AUSTIN

DATE: March 7, 2011

TITLE: Visual Evaluation of Unweathered "U" Series Samples

BY: Payal Vora

VISUAL EVALUATION OF UNWEATHERED "U" SERIES SAMPLES

PURPOSE:

The soiled unweathered "U" series of experimental brick samples prior to cleaning evaluations appeared to be different from other unweathered samples used for various trials that were treated similarly to the "U" series. The purpose of this report was to visually evaluate the conditioned and soiled unweathered "U" series of brick samples prior to cleaning evaluations on the soiled samples.

SAMPLES:

Brick samples with nominal dimensions of 2 x 4 x 0.5 inches, soaked in sea water (3.2% salinity), soiled with a mixture of 10% odorless mineral spirits (mineral spirits) and weathered crude oil (oil), and placed in an oven at 100°F for 18 hours to evaporate mineral spirits from the sample surface were visually evaluated .

MATERIALS AND EQUIPMENT:

Brick samples soiled as described above

PROCEDURE:

A total of 36 brick samples with nominal dimensions noted above were soaked in sea water for 24 hours. Each soaked sample was blotted dry and weighed prior to being soiled with 1 g of a mixture of oil and 10% mineral spirits in order to facilitate soiling. The soiling was applied to the sample surface using a 0.025 inch (25 mil) drawdown tool.

The soiled brick samples were placed in an oven at 100°F for approximately 18 hours in order to evaporate the mineral spirits and prepare the samples for conducting cleaning evaluations. Five colorimetry readings per sample were taken after the 24 hour soaking period and again after 18 hours when the samples were removed from the oven.

TEST RESULTS:

Figures D.41 and D.42 show the brick samples after being soiled and being in the oven at 100°F for 18 hours. As seen in Figures D.43 through D.46, the samples appeared to have heavy efflorescence and a layer of sand on the surface.

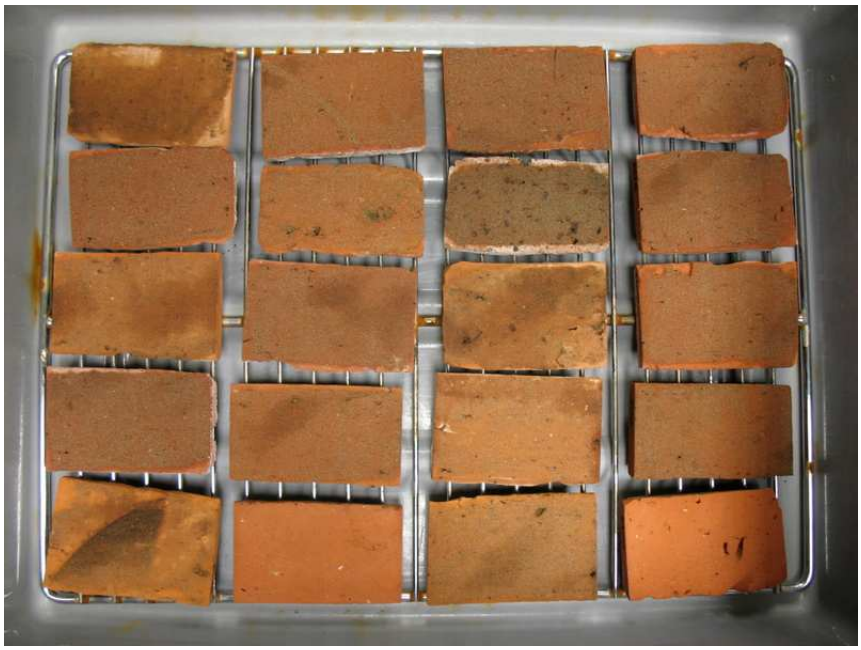

Figure D.41. Bricks after soaking in seawater, soiling, and being in the oven at 100°F for 18 hours.

Figure D.42. Bricks after soaking in seawater, being soiled, and being in the oven at 100°F for 18 hours.

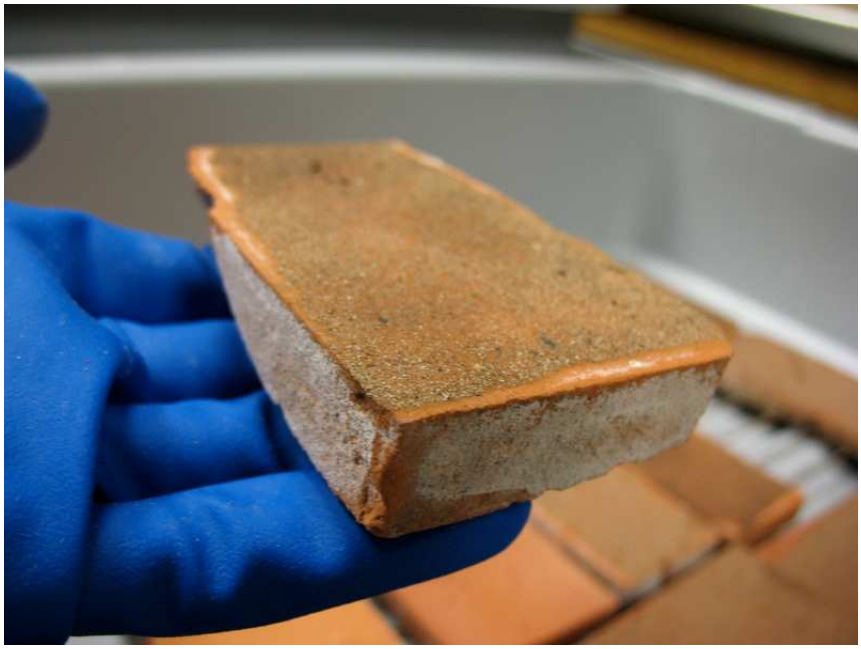

Figure D.43. A sample with a layer of sand on the surface and efflorescence on the sides. Note: there is minimal efflorescence on the cut surface of the brick.

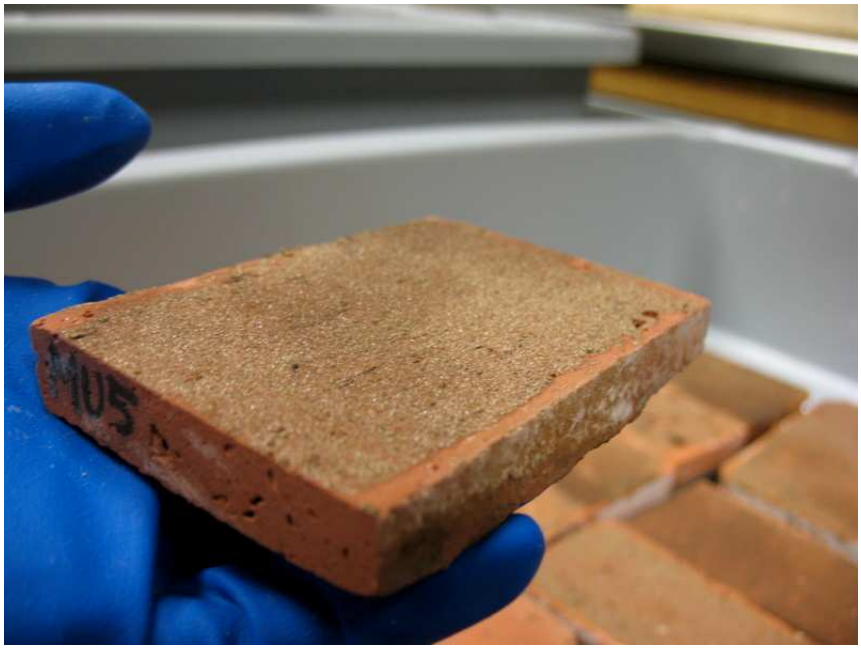

Figure D.44. Another sample with a layer of sand on the surface and efflorescence on the sides. Note: there is minimal efflorescence on the cut surface of the brick.

Figure D.45. An unsoiled control sample with efflorescence on the sides but not on the cut surface.

Figure D.46. Heavy efflorescence on the back of the control sample.

DISCUSSION OF RESULTS:

The layer of sand was likely within the oil that was mixed with mineral spirits before being used to soil the brick. The sand may have affected the quantity of soiling deposited on the brick surface, and the depth of penetration of soiling into the brick surface. Sand in the oil may affect the results of cleaning evaluations.

The efflorescence appears to be due to the 24 hour soak in sea water. The cut surfaces may have minimal efflorescence compared to the exterior brick surface due to variations in porosity. This condition was not observed on samples used for the selection of the final six cleaners.

Photomicrographs of various samples at 20x magnification are shown below for comparison. The photomicrographs show an unsoiled sample soaked in seawater after being in a 100°F oven for 18 hours, a soiled sample cleaned with Cytosol, a soiled sample cleaned with GoldCrew, a soiled cleaned sample with a layer of sand, and a soiled sample previously prepared for cleaner selection.

Figure D.47. Conditioned, unsoiled control sample.

Figure D.48. Soiled sample with no sand on the surface. Note: The sample was prepared as an extra sample for final cleaner selection but was not used.

Figure D.49. Soiled sample with a layer of sand on the surface.

Figure D.50. Soiled sample cleaned with GoldCrew.

Figure D.51. Soiled sample cleaned with Cytosol.

A new set of unweathered samples should be prepared for cleaning evaluations in order to maintain consistency in soiling quality and subsequent results of cleaning evaluations.

Appendix E: Visual Survey Form

A. Brick Appearance Survey

Note: **Rank each sample within a group from 1 (least clean, worst) to 6 (cleanest, best) based on your visual examination.**

1. Rank the six samples in group 1. _____ _____ _____ _____ _____ _____
2. Rank the six samples in group 2. _____ _____ _____ _____ _____ _____
3. Rank the six samples in group 3. _____ _____ _____ _____ _____ _____
4. Rank the six samples in group 4. _____ _____ _____ _____ _____ _____
5. Rank the six samples in group 5. _____ _____ _____ _____ _____ _____
6. Rank the six samples in group 6. _____ _____ _____ _____ _____ _____
7. Rank the six samples in group 7. _____ _____ _____ _____ _____ _____
8. Rank the six samples in group 8. _____ _____ _____ _____ _____ _____
9. Rank the six samples in group 9. _____ _____ _____ _____ _____ _____
10. Rank the six samples in group 10. _____ _____ _____ _____ _____ _____
11. Rank the six samples in group 11. _____ _____ _____ _____ _____ _____
12. Rank the six samples in group 12. _____ _____ _____ _____ _____ _____

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